INDIAN PHYTOPATHOLOGY

VOLUME IX 1956 NUMBER 2

(ISSUED MARCH 1957)

PUBLISHED FOR

INDIAN PHYTOPATHOLOGICAL SOCIETY
I. A. R. I. BUILDINGS, NEW DELHI-12
INDIA

TABLE OF CONTENTS

REJECTION OF THE NAME OF AMBLYOSPORIUM ECHINULATUM

KEISUKE TUBAKI

(Accepted for publication April 3, 1956)

In this paper, an account is given of the morphology and taxonomy of *Amblyosporium echinulatum* Oudemans. In 1862, Fresenius published a monotypic genus *Amblyosporium* with *A. botrytis* F. which was found originally on *Agaricus*. As far as I am aware, the following six species of *Amblyosporium* have been hitherto described: *A. botrytis* F. (1863), *A. album* Richon (1889), *A. umbellatum* Harz (1871), *A. bicollum* Cost. (1887), *A. alboluteum* Cost. (1887) and *A. echinulatum* Oud. (1902). Among them, *A. umbellatum*, *A. bicollum*, *A. alboluteum* and *A. album* were later taken to be synonyms of *A. botrytis* by Lindau (1907). All members were described on mushroom except for *A. echinulatum*, which was described on *Nicotiana tabacum* (1902) and from soil (1933), and is unique in the form of echinulate conidia. Its original diagnosis is as follows: Rasen kriesrund, graugrün. Sterile Hyphen kries rund, hyalin, verzweight, bis 10μ breit. Konidientrager aufrecht, unverzweigt, unseptiert, 10μ breit, an der Spitze blass graugrün, angeschwollen und mit meheren, ca. 25 μ langen Aestchen versehen, die kegelförmig gestaltet sind und in dichten Kreisen oder in kontinuierlicher Spirale stehen. Konidien in ketten angeordnet, ellipsoidisch oder eiformig, beidendig abgestutz, sehr fein stachlig, schmutzig graugrün. 8-12 μ lang, 6–9 μ briet. Hab. auf faulenden Stengeln von *Nicotiana tabacum* bai Bussum in Holland im August.

The verticillate or spirally arranged branches as shown in the above description is the important characteristic of *Amblyosporium*. The following cultures of the members of *Amblyosporium* were used for this investigation.

Name	Origin
Amblyosporium echinulatum	C. B. S. (Baarn, Holland)
,, ,,	I. F. O. (Oosaka, Japan)
,, *albolutenm*	C. B. S. (Baarn, Holland)
,, *botrytis*	C. B. S. (Baarn, Holland)

In the cultivation on ordinary malt agar (5% malt powder, 2% glucose, 0.1% peptone and agar) plates, *A. botrytis* and *A. alboluteum* showed abundant growth and formed loosely floccose and orange coloured colonies. Conidiophores branch characteristically, terminated by a number of divaricated branchlets on which the conidial chains are borne. On the contrary, both strains of *A. echinulatum* are specified by their very restricted growth (2–4 mm. in diameter after 2 weeks at 25°C.), pale yellowish green or almost hyaline surface and deep orange colour of the reverse of colonies. Aerial hypae are sparsely formed, much branched and sinuous,

irregularly branched, 3.5–5.5 μ in diam., hyaline. Conidiophores are erect from aerial hyphae and are simple or branched, usually short, rather thick-walled, septate, terminating by irregular branches on which the conidial chains are borne, often terminated by sphaeroid or clavoid swelling in which branches are produced. Occasionally, the branches produce secondary branchlets, 3.4–16.2 X2.8–5.1μ hyaline. Conidia sphaeroid, ovoid or pyriform, echinulate, 5.4–8 μ long in average, connected by bars, hyaline or pale yellowish coloured.

When cultivated on malt agar containing 5–10% of NaCl, both strains showed characteristic features of *Aspergillus* and moreover abundant perithecia were produced. On the contrary, the *Amblyosporium*-type is shown on the oridinary media, but, when the media are dried out and the density of salt in it is condensed, the *Aspergillus*-type head is gradually produced.

The present author designates here the present species, on the basis of the characteristics of these strains on 10% NaCl-malt agar as follows: Growth slow, but spreading, plane, mottled due to a number of conidial fructifications, at first "Bottle-Green" (Ridgway) coloured, then becoming reddish brown or maroon as orange red perithecia develop. Conidiophores erect from aerial hyphae with foot cells at their bases, smooth-walled, with sphaerical vesicles at their tips, 500–800 μ long in average, 5–8 (16) μ in diam., hyaline or pale brown-coloured. Sterigmata arranged radiately on surface of terminal vesicles of conidiophores, 9.2–13.5 X 4.5–6.7 μ, continuous, producing conidia basipetally from each tips. Conidia ellipsoid, ovoid or pyriform, minutely echinulate, 7–8 (9) X 6.5–8.5 μ. Perithecia abundant, embedded in loose felt of reddish aerial hyphae, commonly sphaeroid, 100–160 μ in diam., yellow; asci 8-spored, 17.5–22.5 μ in diam.; ascospores lenticular, showing equatorial and longitudinal furrow, ridge low or pyramidal, conspicuously roughened, 6.5–7.5 X 5.0–6.0 μ, yellowish coloured.

Discussion

As shown from the above examination of the two strains of *Amblyosporium echinulatum*, it is clear that these strains are not of the genus *Amblyosporium* Fres. The present author consideres these are conspecific with *Aspergillus mangini* Thom et Raper in *Aspergillus glaucus* Group which has yellow and echinulate ascospores. In general, the character of the growth of *A. glaucus* Group is strongly influenced by the culture medium, and their characteristic feature cannot be observed on the low salt concentration media. The morphological features of *A. glaucus* Group on such unfavourable conditions are as follows: a) increase of septation on aerial hyphae and conidiophores. b) prolongation and branching of sterigmata. c) lack or limited formation of vesicles.

In such condition, *Amblyosporium*-type conidial apparatus may be found in almost all members of *Aspergillusglaucus* Group. Moreover, the present strains agree well with *A. mangini*. From this view-point, some members of *A. glaucus* Group growing under unfavourable conditions are thought to have been taken as species of *Amblyosporium*. *Aspergillus*

echinulatus which produces large conidia among *A. glaucus* Group seems nearest *A.echinu- latum* from the viewpoint of conidial size of literature.

Type strains of *Amblyosporium alboluteum* and *A.botrytis* showed sparse growth on high salt concentration media and produced no conidial apparatus.

Up to the present, *Eurotium* Berkeley (1857), *Diplostephanus* Langeron (1922) and *Sartorya* Vuillemin (1927) have been called perfect stages of *Aspergillus*, and *Sterigmatocystis* Cramer (1911), *Euaspergillus* Ludwig (1892) and *Aspergillopsis* Spegazzini (1911) were taken to be synonyms of *Aspergillus* Micheli ex Fr. In addition to the above names, the following generic names have been applied to the species of *Aspergillus*: *Alliospora sapucaya* Pim=Black form of *Aspergillus*. *Ascophora nigricans*=*Aspergillus niger*. *Cladosarum olivaceum* E. et Yuill=mutant of *Aspergillus niger*.

Thus *Amblyosporium echinulatum* must be rejected for the reasons that this may be covering more than one species of *Aspergillus glaucus* Group.

SUMMARY

The taxonomy of *Amblyosporium echinulatum* was considerated, based on its cultural features. As a result, this species was found to be no more than the malformed stage of some members of *Aspergillus glaucus* Group produced under unfavourable conditions. Almost all species of *A. glaucus* Group, which are osmophilic, can produce the conidial fructifications of *Amblyosporium*-type when they are cultured on media of low salt concentration.

ACKNOWLEDGEMENTS

The present author wishes to thank Dr. K. Kominami, Director of Nagao Institute, and Dr. Y. Kobayasi, National Science Museum, for their continuous guidance in the course of this work.

Nagao Institute, Kitashinagawa, Tokyo, Japan.

REFERENCES

SACCARDO P. A. (1886) Sylloge Fungorum IV:77

LINDAU G. (1907) Rabenhorst's Krypt. Fl. Pilze VIII:178

Ma, R. M. (1933) A Study of the soil Fungi of the Peking district. *Lingnan Sci. J.* Supp. ffiII : 115.

THOM, C., & RAPER K.B. (1945) A Manual of the Aspergilli. Williams & Wilkins Co., Baltimore, p. 131.

GILMAN J. C. (1945) A Manual of Soil Fungi. Iowa State College Press, Iowa, p. 200.

EXPLANATION OF THE PLATE.

A–B. *Amblyosporium echinulatum*, after 7 days, at 25°C.

A. On ordinary malt agar plate.

B. On 10% NaCl-malt agar plate.

Explanation of Text Figures

Figure — I

Amblyosporium echinulatum, on ordinary malt agar. Several stages of conidiophores, sterigmata and conidia.

Figure — 2

Amblyosporium echinulatum, on 10% NaCl-malt agar.

A. Conidiophores with foot-cell, sterigmata and conidia.

B. Ascus. C Ascospores.

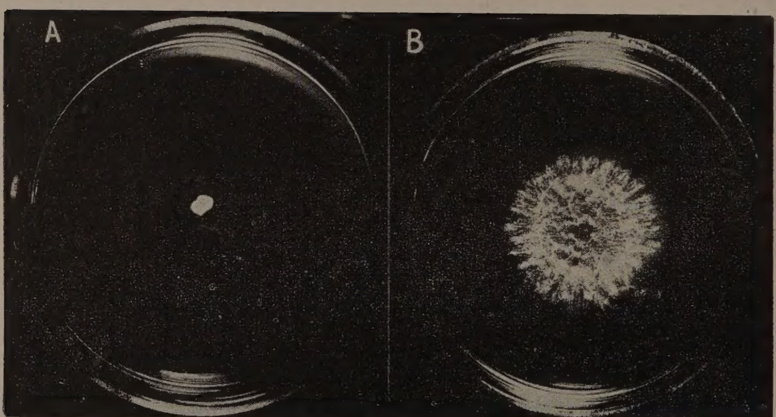


Plate 1

TEXT FIGURES

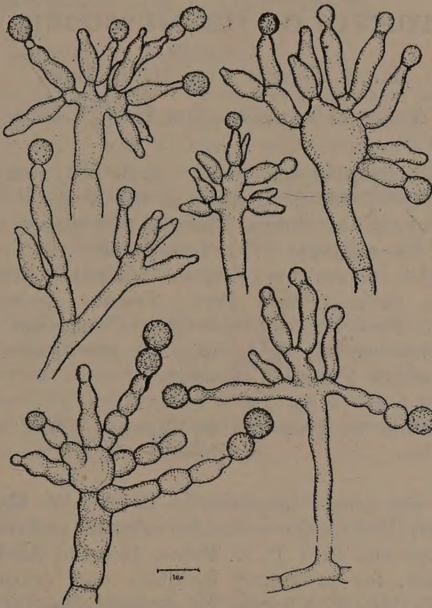


Fig. 1

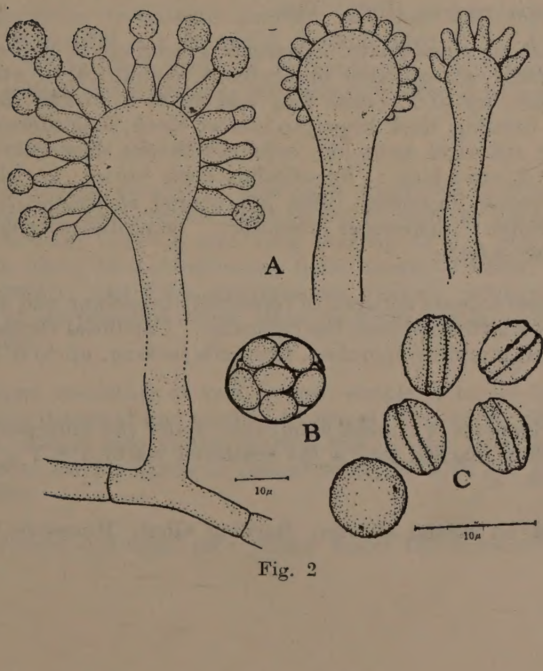


Fig. 2

THE MYXOMYCETES OF THE MUSSOORIE HILLS - III

K. S. Thind and H. S. Sohi

(Accepted for publication April 20, 1956)

This paper is intended to record more Myxomycetes from the Mussoorie Hills (5,000–7,000 ft. altitude in the North-Western Himalayas) as a part of the study of the Fungal Flora of that region undertaken by the senior author and his students (Thind and Sohi, 1955., Thind and Sohi, 1956). All the eight species described in this paper belong to the Order Trichiales. *Trichia varia* (Pers.) Pers., *Trichia scabra* Rost., *Trichia favoginea* (Batsch) Pers., and *Hemitrichia Vesparium* (Batsch) Macbr. reported here are new records for India. All the specimens are deposited in the Herbarium of the Punjab University.

The classification as proposed by Martin, 1949, has been followed in the present series.

The authors are deeply indebted to Dr. G. W. Martin of the State University of Iowa, U.S.A., for valuable criticism and help in the identification of the species and Prof. P. N. Mehra, Head of the Punjab University Botany Department, for providing facilities and encouragement. They are also thankful to Mr. B. Khanna for making illustrations of the fructifications.

Order: Trichiales

15. *Arcyria cinerea* (Bull.) Pers.

Fructifications sporangiate. *Sporangia* gregarious to densely crowded, stipitate, typically ash-coloured or cinereous, cylindrical to ovato-cylindrical, apex obtuse, up to 1.6 mm. long and up to 0.45 mm. broad: stipe long, erect or bending, dark brown to almost black, longitudinally grooved, filled up with spherical spore-like cells, which are, however, larger than spores, up to 2 mm. long : hypothallus dark brown to black, rotate: peridium cinereous, fugaceous, often left behind as fragments on the expanded capillitium: dehiscence irregular: calyculus concolorous, small, striated on the outside.

Capillitium a dense network of repeatedly branching and anastomosing elastic threads which arise from the calyculus. Capillitial threads cinereous, abundantly and minutely spinulose, free ends lacking, up to 6.3 μ in thickness.

Spores cinereous in a mass, subhyaline under the microscope, rounded, almost smooth or marked with a few scattered warts, 7–8.7 μ in diameter. Text-Fig. 1, A - C.

Collected on rotten stumps, Burning Ghat, Mussoorie, July 28, 1952, 75.

The species is characterised by cinereous colour of the sporangia, long stipe, dense capillitium expanding only slightly after dehiscence, and almost smooth small spores (7–8.7 μ in diameter).

16. *Arcyria denudata* (L.) Wettst.

Fructifications sporangiate. *Sporangia* gregarious to densely crowded, stipitate, bright red, fading with age, ovatocylindrical, slightly narrowed above, apex obtuse, 2–2.5 x 0.97 mm: stipe long, erect or bending, dark brown to almost black, filled up with spherical spore-like cells which are, however, bigger than the spores, inconspicuously grooved longitudinally, more or less uniform in thickness, 1.3–1.42 mm. long: hypothallus small, dark brown, rotate: peridium fugaceous except the calyculus: dehiscence irregular: calyculus distinctly striated.

Capillitium elastic and considerably expanded after the disappearance of the evanescent peridium, composed of a dense network of repeatedly branching and anastomosing red threads, attached to the calyculus. Capillitial threads marked by complete or half rings giving a warted appearance, almost smooth or without conspicuous markings near their point of origin from the calyculus, 3–4 μ in thickness.

Spores reddish in a mass, lighter coloured under the microscope, globose to subglobose, smooth, or with a few scattered minute warts, 5.2–7 μ in diameter.

Plasmodium orange coloured, forming a network over the substratum. Text-Fig. 2, A - C.

Collected on rotten wood, The Park, Mussoorie, Sept. , 1952, 76.

This species is exceedingly common and was collected from several localities of Mussoorie. It is easily differentiated from *Arcyria cinerea* (Bull.) Pers. by the red colour of its sporangia, capillitium and spores and by the capillitium expanding considerably after dehiscence.

17. *Trichia varia* (Pers.) Pers.

Fructifications sporangiate. *Sporangia* gregarious to densely crowded, sessile to short stipitate, yellow, dull yellow to shining, variable in shape, globose to obovoid, 0.4–0.8 mm. long and up to 0.7 mm. wide: stipe, when present, short to inconspicuous, dark brown to black: hypothallus small, dark brown: peridium membranous, yellow: dehiscence irregular, by rupturing of the peridium above while its lower portion remaining persistent like a cup.

Capillitium consisting of long, yellow, simple or rarely branched, free elaters, 3–5 μ in diameter and marked by usually two, rarely three, irregular spiral bands., elaters also appear warted due to the irregular extending out of the spiral bands., apices of elaters acute, or with one end acute and other knob-like.

Spores yellow in a mass, pale yellow under the microscoope, globose,

inconspicuously verrucose to almost smooth, guttulate, 12–14 μ in diameter. Text-Fig. 3, A - D.

Collected on rotten wood, Forest Research Institute, Dehra Dun, Sept. 5,1951, 77. On rotten wood, The Park, Mussoorie, Aug. 20, 1952, 78. on decaying bark, The Municipal Garden, Mussoorie, Aug. 28, 1953, 79. New record in India.

This species is exceedingly common in the Mussoorie Hills. It is characterized by sessile to stalked and variable shape of sporangia, with usually two spirals on the elaters, and inconspicuously verrucose, guttalate spores.

18. *Trichia scabra* Rost.

Fructifications sporangiate. *Sporangia* gregarious to densely crowded, sessile, dull yellow, globose to obovoid, 0.6–0.7 mm. in diameter: hypothallus well developed, common to a sporangial patch: peridium membranous, yellow smooth: dehiscence irregular, by rupturing of the peridium at the top, while its lower portion remaining persistent like a cup.

Capillitium consisting of long, golden yellow, simple, free elaters, 3–4 μ wide, spinulose and marked by 4–5 spiral bands, apices short and acuminate.

Spores golden yellow in a mass, yellow under the microscope, globose, finely reticulate, reticulations often incomplete, 9—11 μ in diameter. Text-Fig. 4, A - C.

Collected on rotten wood, The Park, Mussoorie, Aug. 20, 1952, 80. New record in India.

This species is easily differentiated by its finely reticulated spores and elaters with 4–5 spiral bands.

19. *Trichia favoginea* (Batsch) Pers.

Fructifications sporangiate. *Sporangia* compactly crowded together into yellow sporangial clusters extending more than 4 cm. over the substratum, sessile, dull yellow to golden yellow, ovoid to cylindrical or obovoid, up to 1 mm. long and 0.4–0.6 mm. broad: hypothallus well developed and common to a sporangial patch: Peridium membranous, yellow, smooth, relatively persistent: dehiscence irregular, by rupturing of the peridium at the top, the lower portion remaining behind like a cup.

Capillitium consisting of long, yellow, free, simple or rarely branched elaters, 5–7 μ in diameter, conspicuously spinulose and marked by 4–5 spiral bands: apices acute to acuminate, sometimes knob-like, sometimes bearing 1–3 spine-like processes. Capillitium, after dehiscence, escaping wholly from the lower persistent peridium and forming yellow woolly masses above it.

Spores golden yellow in a mass, bright yellow under the microscope, globose, reticulate, reticulations very nearly complete, bands narrow, high and with conspicuous pits, 11–14 μ in diameter. Text-Fig. 5, A - C.

Collected on rotten wood, Kempty Fall, Mussoorie, Aug. 13, 1952, 81. New record in India.

This species is characterized by its sporangia arranged into large, compact, yellow crust-like clusters, and by its spores marked by small, wide-meshed, irregular but often complete reticulations with narrow and pitted bands. In the last respect it is related to *Trichia persimilis* P. Karst.

20. *Hemitrichia serpula* (Scop.) Rost.

Fructifications plasmodiocarpous. *Plasmodiocarps* large, spreading up to several centimeters over the substratum, exactly plasmodial in nature and forming a complete netted structure without any separate units, i.e., the entire original plasmodium giving rise to one large plasmodiocarp, bright yellow, rusty or tawny, terete, 0.3 - 0.6 mm. in diameter: hypothallus conspicuous, yellowish brown to dark brown: peridium thin, membranous, transluscent: dehiscence irregularly longitudinal, peridium rupturing along the top, the lower portion remaining persistent longer.

Capillitium consisting of a tangle or cluster of yellow, convoluted, sparingly branched, elastic threads, up to 6μ in diameter, abundantly spinulose and marked by 3 – 4 spiral bands; apices of elaters acuminate, very rarely knob–like.

Spores yellow, globose, coarsely reticulate, 12 – 14.5μ in diameter. Text–Fig.6,A - B.

Collected on rotten wood, Jabbar Khet, Mussoorie, Sept. 18, 1952, 82. On mosses, St. George College, Mussoorie, Aug. 30, 1953, 83.

This species is abundantly common in the Mussoorie Hills and is easily recognised by its large, netted, yellow plasmodiocarps and coarsely reticulate spores.

21. *Hemitrichia clavata* (Pers.) Rost.

Fructifications sporangiate. *Sporangia* gregarious to crowded, short stipitate to almost sessile, yellow, clavate or pyriform, 1 - 1.5 mm. tall and up to 0.7 mm. broad: stipe short, dark brown below, brown above, filled with spore–like cells, expanding into the sporangium above: hypothallus conspicuous, thin, dark brown: peridium membranous, transluescent, shining : dehiscence irregular, peridium rupturing at the top while its lower portion remaining persistent like a cup.

Capillitium consisting of a tangle of long, yellow, elastic, sparingly branched, convoluted threads, up to 5.5μ wide, marked by 4 - 5 spiral bands which are roughened or finely echinulate; free ends few, swollen, with or without a large spine–like process.

Spores brownish yellow in a mass, yellow under the microscope, globose, coarsely papillate, papillae elongated into ridges which are united to form a reticulation, thus giving a reticulate appearance to the spore surface, 7.5 - 9μ in diameter. Text–Fig.7,A - C.

Collected on rotten wood, The Park, Mussoorie, July 31,1952, 84.

This species is recognised by its hollow stipes merging gradually with the vase–like base of the peridium, minutely echinulate capillitium, and coarsely papillate spores, papillae being elongated into ridges which form reticulations at the spore surface.

22. *Hemitrichia Vesparium* (Batsch) Macbr.

Fructifications sporangiate. *Sporangia* densely crowded together, stipitate. dark wine red, turning reddish black with age, clavate or subcylindric, 1 - 1.6 mm. tall and up to 0.5 mm. broad: stipes long, erect, solid, all fused together or blended under a sporangial cluster, concolorous with the sporangia, the fused stipes giving a grooved or flutted appearance: hypothallus small, concolorous: peridium thin, opaque, shining: dehiscence irregularly circumscissile, the dome-shaped top of the peridium falling away, while its basal portion remaining persistent as a deep cup.

Capillitium coming out as woolly mass above the sporangia after dehiscence, composed of long, inter–twisted, highly convoluted, sparsely branched, reddish threads, 5 - 6.5 μ wide, profusely spinulose, spines sharp, marked by 3 - 4 spiral bands; free ends acute or swollen or hooked.

Spores brownish-red in a mass, lighter coloured under the microscope, globose, profusely and minutely verrucose, 10 - 11 μ in diameter. Text-Fig.8, A - C.

Collected on rotten wood, Jabber Khet, Mussoorie, Aug. 3, 1952, 85. New record in India.

This species is readily recognized by the red colour of its sporangia, capillitium, and spores, fasciculate habit due to the fusing together or blending of all the stalks of a sporangial cluster, and a strong tendency toward circumscissile dehiscence. The peridium persists like a deep cup after dehiscence and in this condition resembles a wasp's nest, suggesting the name *vesparium* applied by Batsch.

Botany Department,
Panjab University,
Amritsar.

References

Agnihothrudu, V. (1954) Some Slime–Moulds from Southern India - II. *J. Indian Bot. Soc.*, **33**: 182–188.

Bruhl, P. and J. S. Gupta. (1927) Indian Slime Fungi (Myxomycetes or Mycetozoa). *Jour. Dept. Science, Calcutta Univ.*, **8**: 101–122.

HAGELSTEIN, R. (1944) The Mycetozoa of North America. New York.

LISTER, G. (1924) Mycetozoa from North India. *Jour. Bot.* **62**: 16–20.

LISTER, A. and G. LISTER. (1925) A Monograph of the Mycetozoa, 3rd. ed. London.

LODHI, S. A. (1934) Indian Slime-Moulds (Myxomycetes), Lahore.

MACBRIDE, T. H. and G. W. MARTIN. (1934) The Myxomycetes, New York.

MARTIN, G. W. (1949) North American Flora 1 : 1 (Myxomycetes), The New York Botanical Garden, 1949.

THIND, K. S. and H. S. SOHI. (1955) The Myxomycetes of the Mussoorie Hills - I. *Indian Phytopathology* **8** : 150—159.

——————— (1956) The Myxomycetes of the Mussoorie Hills - II. *Indian Phytopathology* **9** : 1—8.

EXPLANATION OF TEXT-FIGURES

Fig. 1. Arcyria cinerea (Bull). Pers., A. Sporangia, X 20 B. Part of Capillitium, X 880 C. Spores. X 880

Fig. 2. *Arcyria denudata* (L) Wettst. A. Sporangia, X 20. B. Part of Capillitium, X 880 C. Spores. X 880

Fig. 3. *Trichia varia* (Pers). Pers., A. Sporangia, X 20 B. Elater. with spiral bends and acute apices, X 380 C. Part of an elater (magnified) with spiral bands and a knob-like end, X 880 D. Guttulate spores. X 880

Fig. 4. *Trichia scabra* Rost., A. Sporangia, X 20 B. Part of elater with acuminate apex, spinulose and marked by spiral bands, X 880 C. Finely reticulate spores. X 880

Fig. 5. *Trichia favoginea* (Batsch) Pers., A. A compact sporangial cluster, X 20 B. Part of elater will acuminate apex X 880 C. Spores with narrow, pitted, reticulate bands. X 880

Fig. 6. *Hemitrichia Serpula* (Scop.) Rost., A. Part of a plasmodiocarp, X 20 B. Coarsely reticulate spores. X 880

Fig. 7. *Hemitrichia clavata* (Pers.) Rost., A. Sporangia, X 20 B. P of a Capillitial thread with swollen and bearing a spine a marked by 4–5 finely echinulate spirals, X 880 C. Spores with papillae elongated into ridges which form a surface reticulation. X 880

Fig. 8. *Hemitrichia Vesparium* (Batsh) Macbr., A. A sporangial cluster with fused stipes, X 20 B. part of capillitial threads with variable apices marked by 3–4 spinal bands. X 880 C. Verrucose spores. X 880

TEXT FIGURES

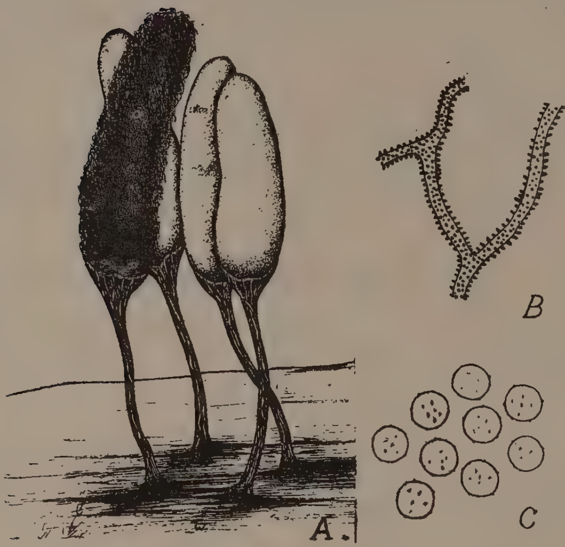


Fig. 1

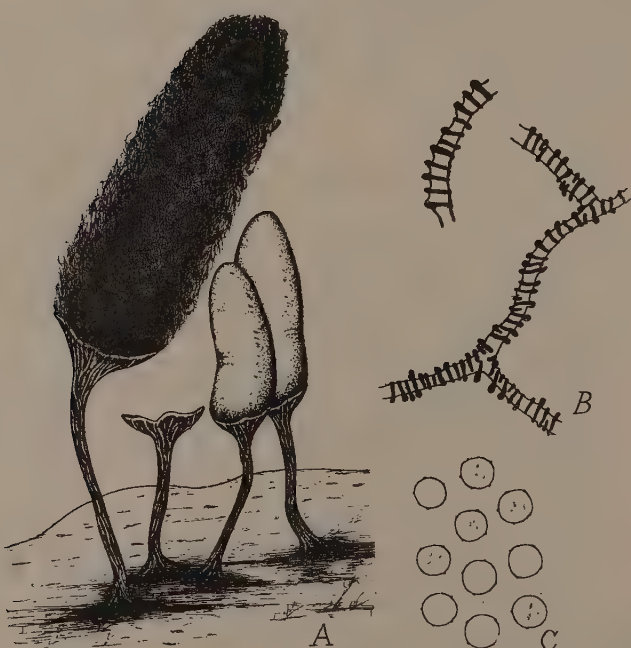


Fig. 2

TEXT FIGURES

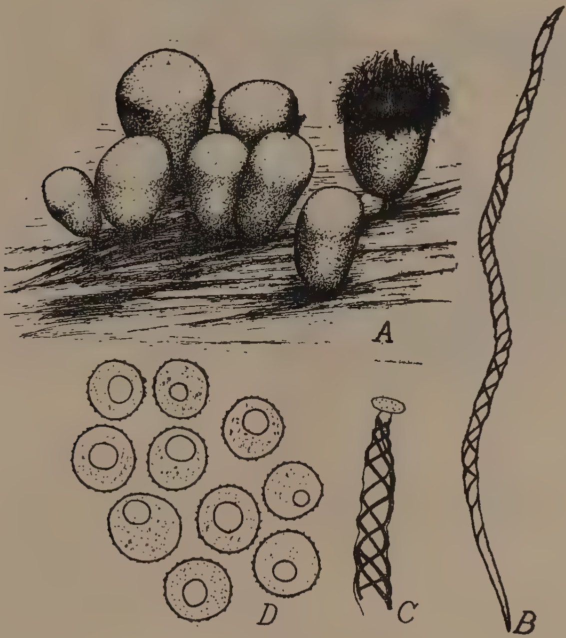


Fig. 3

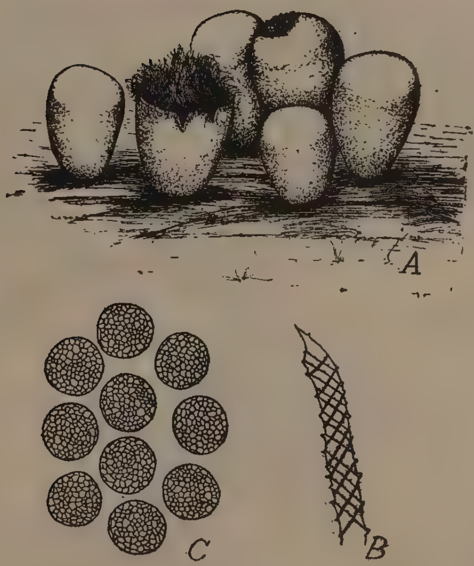


Fig. 4

TEXT FIGURES

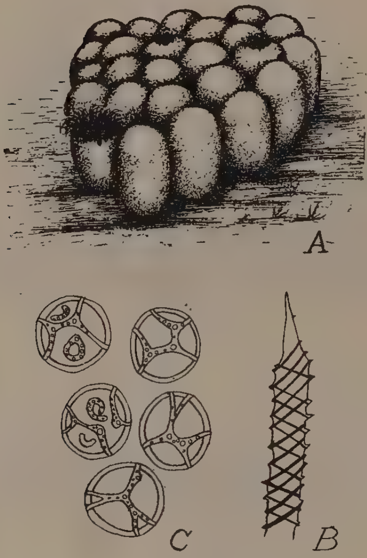


Fig. 5

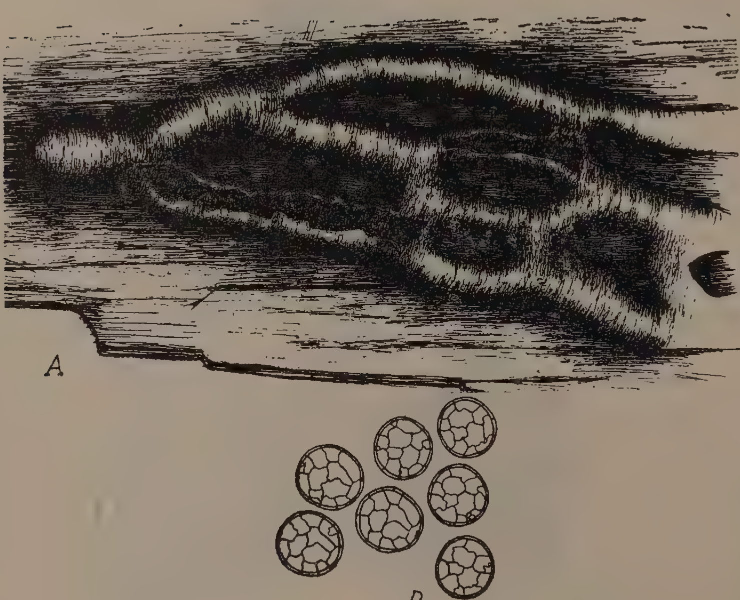


Fig. 6

TEXT FIGURES

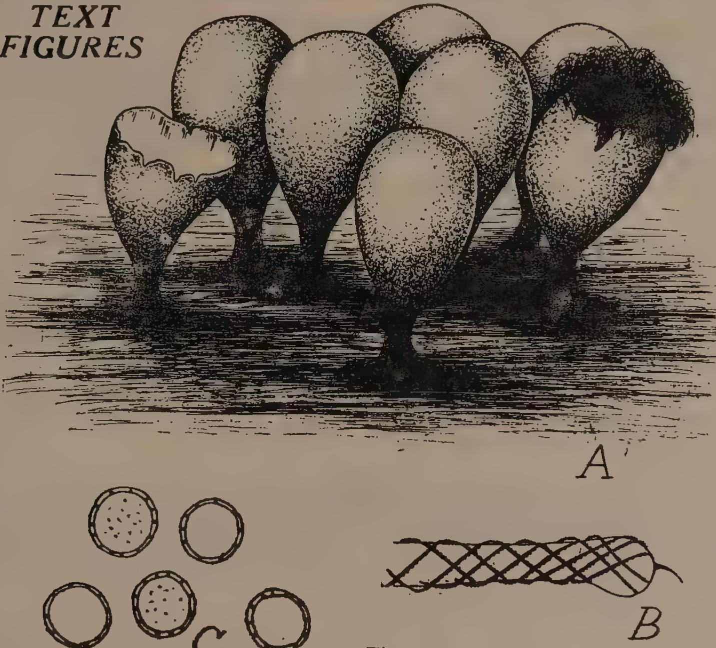


Fig. 7

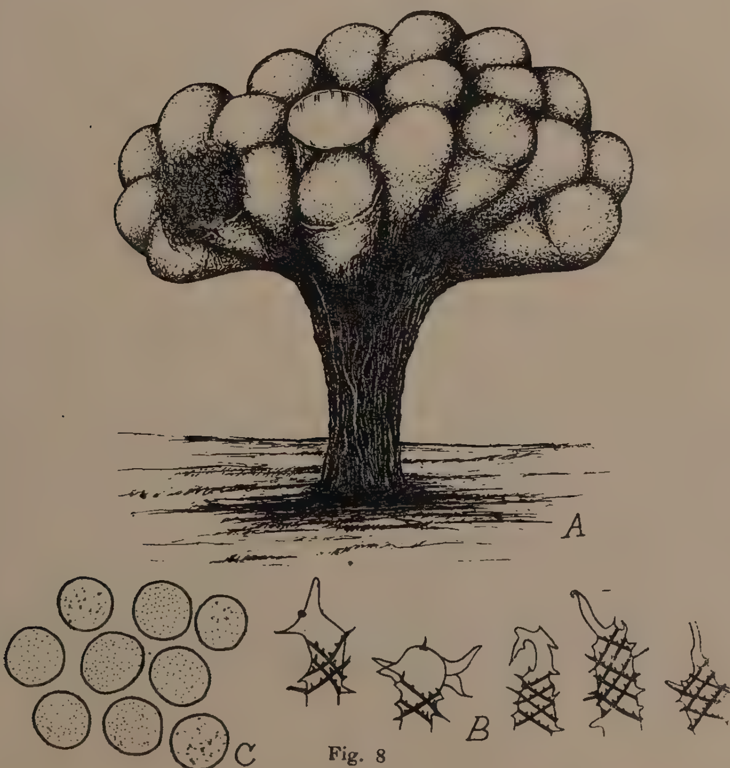


Fig. 8

CICINNOBOLUS CESATI DEBARY : HYPERPARASITE OF POWDERY MILDEWS IN INDIA

B. L. CHONA AND R. L. MUNJAL

(Accepted for publication May 25, 1956)

In temperate countries, species of *Cicinnobolus* are well known as parasites of powdery mildews caused by members of *Erysiphaceae* but in India, it is of rare occurrence and only two such cases have been reported so far. SYDOW and BUTLER (1916) reported the occurrence of *C. cesati* on *Oidium* sp. parasitising *Phaseolus vulgaris* from Pusa for the first time, and the second by VENKATARAYAN (1946) from Banglore on *Oidiopsis taurica* on *Cyamopsis psoraloides*.

Some more specimens recently collected from North Western and Southern parts of the country (Simla, Almora and Nilgiris) at altitudes varying from 1000 feet to 7000 feet, have been studied which are described here host wise:

Cucurbitaceae:

1. *Cucurbita moschata* DUCHESNE ex POIR - Leaves of this plant which were showing whitish, circular patches of powdery mildew (*Oidium* sp.) were found to be turning olivaceous and later drak greyish--olive in colour. Also the white loose growth of hyphae of the powdery mildew was replaced by a thick compact mat of hyphae, covering slightly larger area of the leaf than that occupied by the mildew. This developed both on the upper as well as the lower surface of the leaf, being more common on upper surface as this surface had greater number of mildew patches. This change in colour was found to be due to profuse growth of the hyperparasite. The olivaceous mat contained innumerable small dot–like olivaceous coloured specks, which imparted this new colour to whitish subicle.

Microscopic examination showed the disintegration and crumpling of conidia and conidiophores of *Oidium*. The conidiophores had become olivaceous and were bearing at their ends globose to elliptic or lemon shaped bodies, from which hyaline, elliptic, single celled spores came out in *Cirrhi* (Spore tendrils). These globose bodies are the pycnidia of the hyperparasite *Cicinnobolus*. Mycelium, conidiophores and oidia were found to be parasitised. Hyphae of the hyperparasite are colourless at first but become ochraceous later due to the accumulation of the protoplasmic contents, are 4–5μ thick ordinarily but sometimes may be isodiametric with the hyphae of the host, and have many cross septa and very small cells measuring 10–22 μ. Occasionally two hyphae of the hyperparasite may occupy the same hypha of the host. These coloured hyphae terminate into bulged structures, which are transformed into pycnidia. The pycnidia are globose, obclavate to ovate, 40–78 x 25–56 μ (mostly 52–68 x 30–45 μ) and ochraceous to dark brown in colour. The wall of the pycnidium is so thin

and transperent that the spores become visible under changed focus. The pycnidial wall appears net like and is formed of polygonal cells. There is no regular ostiole but the wall of the pycnidium is thinner towards apex, which ruptures, releasing the spore mass inside which comes out in the form of *Cirrhi*. Spores are hyaline, mostly elliptic to ovate, with one end rounded and the other bluntly acute and with two oil globules, one at each end, single celled and measure 5–9 x 2.5–3.5 μ (mostly 7–8 x 3.5 μ).

After a very thorough search, only two mature perithecia could be found in one spot, which had escaped infection and made possible the exact identity of the mildew. These yielded one ascus each and agreed with the description of *Sphaerotheca humuli* var. *fuliginea*. already recorded on this host.

Collected at Flowerdale, Simla, 6,900 ft. (R. L. Munjal) 20.11.1948.

Sechium edule Sw.

Leaves showed mildew attack on upper surface only. The spots are small, circular, usually separate, rarely coalescing and provided with a whitish fringe of the mildew hyphae, measuring 4–8 mm. in diameter (mostly 5–7 mm). The centre of the spots is dark greyish-olive due to innumerable pycnidia of the hyperparasite. All the spots were found attacked by the hyperparasite. Pycnidia are mostly lemon shaped or ovate, some globose; parenchymatous, ochraceous brown to dark brown in colour and measure 63–48 x 35–66.5 μ (mostly 70–77 x 49–52.5 μ). These may or may not be stalked. Spores come out in *Cirrhi* from the pycnidium. Spores are hyaline, single celled, oblong, upper end rounded, lower in most cases slightly pointed and measure 5–8 x 3 μ (mostly 7–8 x 3 μ) with two oil globules, one at each end.

No perithecia were observed of the mildew, owing to severe infestation of hyperparasite.

Collected at Kotagiri, Coonoor Taluk, Nilgiris, South India, 7000 ft. (R. L. Munjal) 15.12.1951.

Chenopodiaceae:

Chenopodium album L.

The mildew spots are irregular, occur on both the sides of the leaves and cover almost the entire surface. Pycnidia of the hyperparasite are oblong or ovate, rarely globose. ochraceous brown to dark brown in colour and measure 42–70 x 45–42 μ (mostly 56–70 x 38–42 μ). Pycnospores come out in *Cirrhi*. These are hyaline, oblong with upper end round and slightly tapering towards lower end, single celled, 6–9 x 3–4 μ (mostly 7–8 x 3 μ). Only a few perithecia of the mildew were found on the leaves, which were identical to *Erysiphe polygoni* DC.

Collected at Almora, Kumaon Hills, 5200 ft. (M. K. Hingorani) 21. 7. 1951.

Chenopodium ambrosioides L.

Symptoms agree in all respects with the above specimen, except that the pycnidia are somewhat smaller in size. These measure 40–49 x 31.5–45 5μ (mostly 42–45 x 39 μ). Pycnospores are hyaline, similar to those described above and measure 7–8 x 3.5 μ. The host mildew is also identified as *E. polygoni* DC.

Collected at Dharampore, Simla Hills, 5000 ft. (H. P. GUPTA), 13.10. 1951.

COMPOSITEAE:

Zinnia elegans Jacq.

Leaves showed mildew infection by *Oidium* sp. on both the surfaces, though it was more common on upper surface. Mildew patches were not distinct, as they coalesced and covered almost the entire leaf surface. Colour of spots changed from white to dirty dark olive due to very heavy infestations of the hyperparasite. Pycnidia are elliptic, rarely globose, sometimes stalked; yellowish brown to dark brown in colour, parenchymatous and thin walled, and measure 60 – 80 x 35–40 μ (mostly 65–72 x 38–40 μ). The spores come out in *Cirrhi*, are hyaline, oblong with 2 oil droplets, one at each end and measure 6–8 x 3 μ (mostly 7–8 x 3 μ).

Collected at Flowerdale, Simla, 6900 ft. (R. L. MUNJAL) 15.10.1948.

Leguminosae:

Glycine javanica L.

Mildew spots are observed on both the surfaces of the leaves, though more commonly on the upper surface. Spots are mostly single, rarely two or more together, 5 to 10 mm. in diameter, almost round,with whitish loose growth of conidiophores and conidia. Mildew patches gradually become dark brown in colour due to the appearance of hyperparasite. Pycnidia are oval to lemon shaped, thin walled, light brown to dark olive brown in colour, mostly sessile, rarely stalked and measure 31.5–49 x 25–38.5 μ (mostly 42–49 x 28–31.5 μ). Pycnospores are hyaline, single celled, rounded above and slightly pointed below, and measure 5–9 x 3 μ (mostly 6–7 x 3 μ), with two oil droplets, one at each end.

Collected at Shambagnaur, Kodaikanal, Pulney Hills, Madura district, South India, 8000 ft. (R. L. Munjal) 20.12.1951.

Fagaceae:

Quercus sp.

Mildew spots mostly irregular, rarely circular, 5–15 mm. in diameter but several spots coalesce to form an irregular big spot with loose whitish mycelium; spots appearing on both the surfaces of leaf. Except the periphery, the whole spot turns dirty grayish olive in colour due to the

attack of hyperparasite. The subicle becomes compact and pressed against leaf surface and is studded with innumerable dot-like pycnidia of the parasite. Pycnidia, globose, ovate or elliptic, parenchymatous, thin walled, rarely stipitate, dark brown and measure 42–60 x 32–42 μ. (mostly 45–50 x 36–39 μ). Pycnospores are hyaline, single celled, mostly straight a few slightly curved with both ends rounded and measure 5–9 x 3 μ (mostly 7–8 x 3 μ).

Collected at Ootacumund, Nilgiris (South India), 7500 ft. (R.L. Munjal). 12.12.1951.

Menispermaceae:

Tinospora cordifolia Miers.

Mildew spots 5–8 mm. in diameter circular at first, later merging into one another and becoming irregular, occupying more than half of the leaf. Spots mostly on the upper surface; a few on the lower surface also. In the loose whitish growth of the mildew are found dirty coloured patches, mostly in the centre of the spot, where pycnidia of hyperparasite are formed. This dirty colour is due to the pycnidia and olivaceous colour of mature hyphae of the hyperparasite. Pycnidia are elliptic to ovate, rarely globose, dark olivaceous brown, net like and measure 42–56 x 32–35 μ (Mostly 52.5 x 35 μ). Pycnospores are hyaline, single celled, with both ends rounded, oblong tapering towards the lower end, few slightly curved and measuring 6–8 x 3 μ (mostly 7—8 x 3 μ).

Collected at a shady and humid place at Mettupalayam (Foot hill) Coimbatore district (South India), 1000 ft. (R. L. Munjal), 11.12.1951.

Bixa orellana L.

Mildew spots varying from 12–20 mm. in diameter, several, on both surfaces of leaf with loose whitish oidial growth towards the periphery, and the centre studded with many dark coloured pycnidia. These are globose or ovate or lemon shaped with net like surface ochraceous brown to dark brown in colour, mostly sessile and measure 49–87.5 x 35–52 μ (mostly 52–59 x 42–45 μ). Pycnospores come out in *Cirrhi*, are single celled, hyaline, slightly curved, some straight, oblong, somewhat pointed towards the lower end with two oil globules, one at each end and measure 5–8 x 3 μ (mostly 6–7 x 3 μ).

Collected at Kallar, District Nilgiris, South India, 2000 ft. (L. M. Joshi) 16.5.1952.

Host parasite relationship of the Hyperparasite and the powdery mildew was found to be similar in all the collections as reported briefly under *Cucurbita moschata*.

Identity of the Hyperparasite

The genus *Cicinnobolus* was founded by Ehrenberg (1853) but its parasitic relationship with its host, the powdery mildew, was studied by

deBary. Thus for all practical purposes *C. cesati* de Bary is taken to be the Type species for this genus. Since then quite a number of species have been added, thus Saccardo, in Sylloge Fungorum has listed 26 species including varieties. After that, three more species seem to have been further added to the list. The size of pycnidia and pycnospores, as recorded in Sylloge Fungorum or elsewhere, is reproduced below:

	Pycnidia	*Pycnospores*
C. cesati de Bary	23–35 x 9–15 μ	2.5–3 x 1–1.5 μ
(According to Diedicke)	25–60 x 10-25 μ	5–10 x 2–4 μ.
C. plantaginis Oud.	70 x 35 μ	7 x 3.7 μ
C. humuli Fautrey	—	4.6–9.8 x 3 μ.
C. cotoneus Pass.	—	7 x 2.5 μ
C. parasiticus (Cocc.) Sacc.	75 μ	4–5 x 2.5–3 μ
C. uncinulae Fautr.	—	6–8 x 3–4 μ
C. taraxaci Eliasson	40–58 x 36–50 μ	6–7 x 3 μ
C. cocconii Sacc. & Syd.	—	3–3.5 x 1.5 μ
C. cesati de Bary var. *evonymi* F. Tassi	40–50 x 18–40 μ	4–6 x 2–2.5 μ
C. verbenae C. Mass.	60–80 x 30–50 μ	4–7 x 2–3 μ
C. evonymi - japonici Arcang.	45–75 x 27–45 μ	6–9 x 3–4 μ
C. kusanvi P. Henn.	40–60 x 30–40 μ	4–6 x 3–3.5 μ
C. verbenae forma *Euphorbiae helioscopiae* C. Mass. Novit.	30–60 x 15–40 μ	5–8 x 2.5–3.5 μ
C. karstenii Sacc. & Trav.	100–150 μ	—
C. ulicis Adams	34–67 x 27–42 μ	4.5–8.5 x 2–2.8 μ
C. artemisiae Vogl.	80–90 μ	4–6 x 2–2.5 μ
C. hieracii Bubak	49–62 x 28–35 μ	6–11 x 3.5 - 4.5 μ
C. polygoni Potebnia	70 x 21–26 μ	7.5–8.5 x 2.5– μ
C. major Dearn. & Barth.	75–120 x 30–45 μ	6–8 x 3 μ
C. puttemansii P. Henn.	50–80 x 25–40 μ	6–8 x 2.5 μ
C. humuli forma *hesperidis* Bresdola	45–70 x 32–40 μ	6–9 x 3–3.5 μ
C. quercinus Syd.	30–45 x 20–35 μ	6–9 x 2.5–4 μ
C. abelmoschi Bubak	60–100 μ	5.5–9.5 x 2.5–4 μ
C. verbasci Gz. Frag.	60–90 x 20–30 μ	—
C. bremiphagus Naumoff.	60–70 x 35–40 μ	7–8 x 3μ
C. epilobii Ferraris	60–70 x 35–40 μ	7–8 x 3 μ
C. nicotinae	—	—
C. sigacollus Rolden	48–81 x 41–56 μ	4.5–7.5 x 2.5–3.5 μ
C. asteris Hinto & Kato	33.3-62.2x22.2-38.9μ	3.8–5.7 x 2.1–3.1μ

The available literature on *Cicinnobolus* shows that *C. cesati* de Bary is the most widely distributed species in the world and that it is not specialized on any particular genus of *Erysiphaceae*. In host-range also, it is found on powdery mildew affecting members of various unrelated plant families. A lot of confusion has been created in the literature, on account of the fact that Saccardo (1884) published in Sylloge Fungorum, Vol. III, page 216, measurements of pycnidia and pycnospores, which are not true for this species, as they are reported to be too small. It is difficult to say, as to how it occurred. DeBary's original reference (*Beitr. Z. Morph. Und Phys. Pilz.* 1870) was not available to us but through the coutesy of the Director, Commonwealth Mycological Institute, Mr. E. W. Mason, who looked up this reference on our behalf, informed us that "deBary's measurements for pycnospores of *C. cesati*, at any rate, as they occurred on *Erysiphe galeopsidis* were 2.82 μ broad and 7–12 μ long (mean 9.1 μ). He gave measurements from Tulsane and other sources. Our guess is that in transcribing from deBary's description for the Sylloge and then getting it into some sort of formal diagnosis, the length of 12 μ got confused with 1–2 guttulate". We have ourselves checked up further by physical measurements of *C. cesati's* illustrations as reporduced by deBary in his book entitled Vegl. Morphol. und Biologie der Pilze, Mycetozoan, and Bacterien, page 268, figure 119; and Tulsane's diagram as reproduced by Grove (1931) and find that the measurements work out, approximately, to 5–10 x 3 μ for pycnospores and 57 x 35 μ for pycnidia

A large number of species of *Cicinnobolus* have been erected on such characters as changed substrate, size and shape of pycnidia and pycnospores and colour of pycnidia etc. No work has been reported so far on cross inoculations among various species. Emmons (1930), who has done considerable work on the physiology and cytology of *C. cesati*, remarks that there are great variations in size and shape of spores and pycnidia within a single collection and even within a single mount from a single spot of the parasitised mildew. The shape and size of the pycnidium also varies with age and condition of the conidiophores within which it develops. Thus she observed that "in *C. cesati* deBary, the pycnidia are gold brown to deep brown in colour, they may be sessile or stipitate and they may or may not be crowned with a chain of immature shrunken or sometimes partially invaded conidia. The spores are oval, spindle or kidney shaped, unusually inequilateral, thin walled and they are usually biguttulate with a rather conspicuous shining droplet at each end".

Yarwood (1939) observed that the colour of the pycnidium is largely affected by the substrate and also that the pycnidia formed saprophytically are larger in size than those formed on living leaves.

We have also observed great diversity of form, shape and colour of pycnidia within each collection and all these things point out to one thing that the characters employed by earlier workers to separate the species are not on sound footing. A glance at the measurements of the known *Cicinnobolus* species, a list of which has appeared earlier in the text, would show that most of them could conveniently be grouped with *C. cesati*.

Griffiths (1899) included in his list *Cicinnobolus major* Kell.& Swingle obtained from Herb. J. B. Ellis, Fascicle 37, No. 84. Dearness and Bartholomew (1917), not knowing this apparently, have erected a new species under the same epithet and stated it to be differing from *C. cesati* in having larger sized pycnidia and pycnospores fide Saccardo. Rolden (1938) described *C. sigacollus* as a new species on the same grounds. Butler (1916) who first reported this species from India, doubted it to be a new form for similar reasons. We have examined an authentic specimen of *C. major* Dearness & Bartholomew, kindly supplied by Dr. S. P. Wiltshire, Director, C.M.I. Kew and authentic specimens of *C. ulicis* Adams. *C. humuli* Fautrey and *C. quercinis* Syd. through the courtesy of Director, Royal Botanic Gardens, Kew. We do not find any valid reasons for keeping these as separate entities and are, therefore, inclined to think, that these should be made synonymous with *C. cesati* de Bary'.

We, also, do not find any material difference in our nine collections of *Cincinnobolus*, described in this paper. We feel, that the following can be conveniently accommodated in the older known species viz. *C. cesati* de Bary:

Cicinnobolus cesati de Bary

Syn. *C. major* Dearness & Bartholomew
C. sigacollus Rolden
C. humuli Fautrey
C. ulicis Adams
C. quercinis Syd.

On *Oidium* of *Sphaerotheca humuli* var. *fuligenia* parasitic on *Cucurbita moschata; Oidium* sp. parasitic on *Sechium edule, Oidium* sp. on *zinnia elegans; Oidium* sp. of *Erysiphe polygoni* parasitic on *Chenopodium album* and *C. ambrosioides; Oidium* sp. parasitic on *Glycine javanica; Oidium* sp. parasitic on *Quercus* sp., *Oidium* sp. parasitic on *Tinospora cordifolia* and *Oidium* sp. parasitic on *Bixa orellana.* (India).

Specimens examined: Cicinnobolus major Dearness and Bartholomew on *Oidium* sp. on *Grindelia squarrosa* (Ph.) Billings, Mont, Leg. E.T. Bartholomew and E. Bartholomew (August,) 1913. Fungi Columbiani No. 5007.

Cicinnoobolus humuli F. Fautrey on *Oidium erysiphoides* on living leaves of cultivated Hop, Noidon (Cote-do') Leg. F. Fautrey, June 1889-1890 *Cicinnobolus quercinis* Syd. on *Oidium quercinis* Thuem. on leaves of *Quercus pedunculata*, Hakgala, Ceylon., Leg. T. Petch, Jan. 1914 (Sydow: Fungi exotici No. 428).

Cicinnobolus ulicis Adams on Mildew on *Ulex* - Europo - Great sugar loaf mt., Co., Wicklow, Ireland; Leg., Mr. Adams.

Our present collections are just casual collections of plant disease specimens and no serious effort has been made for a thorough search of this fungus. However, there are clear indications that the fungus is likely to be met with both in the hills and the plains. Yarwood (1936) observed

that the spores of this fungus are able to germinate only when free water is present and this may be the possible reason, as to why in the plains, it was found only in shady places. The severe infestation of *Cicinnobolus*, in certain cases, also indicates the possibility of its use as a means of biological control, as in some of the collection, it did not allow the formation of the perithecia.

Our thanks are due to Dr. R. S. Vasudeva, Head of the Division of Mycology and Plant Pathology for providing necessary facilities, for his keen interest, and encouragement during this work. We are grateful to Dr. S. P. Wiltshire, Director, Commonwealth Mycological Institute, Kew and Sir E.J. Salisbury, Director, Botanic Gardens, Kew for providing authentic specimens of various *Cicinnobolus* species on loan; and to Dr. E. W. Mason for his kind help.

Division of Mycology and Plant Pathology,
Indian Agricultural Research Institute,
New Delhi.

References

De Bary, Anton (1870) *Eurotium, Erysiphe, Cicinnobolus:* Nebst Bemerkungen ueber die Geschlechtsorgane der Ascomyceten. *Abhand. Senek. Natur. Ges.*, **7**.

——————(1884) Vergl. Morphologie und Biologie der Pilze, Mycetozoan und Bacterien. 558 pp. Leipzig.

Dearness, J. and E.T. Bartholomew (1917) North American Fungi *Mycologia,* **9** p. 353.

Ehrenberg, C. G. (1853) *Bot. zeit,* **11**(15) : 16.

Emmons, C. W. (1930) A study of Host-Parasite relations. *Bull. Torrey Bot. Club.* **47**(7) : 421-441.

Griffith, David (1889) Common parasites of Powdery Mildews. *Bull. Torrey Bot. Club.* **26**, 184:188.

Roldan, E. F. (1938) New or Noteworthy Lower Fungi of the Philippine Islands - II. *Philipp. J. Sci.* **46** (1) : 7-13.

Sydow, H. & P. and E. J. Butler (1916) Fungi Ind. Orientalis. Part IV. *Ann. Mycol.,* **14** 9 : 10.

Venkatarayan, S. V. (1946) A natural fungus parasite of Powdery mildew on *Cyamopis psoraliodies* DC. *Curr. Sci.,* **15** : 319.

Yarwood, C. E. (1936) The tolerance of *Erysiphe polygoni* DC. and certain other powdery midlews to low humidity - *Phytopath.,* **26** (9) : 845-849.

——————(1939) An overwintering pycnidial stage of *Cicinnobolus*. *Mycologia,* **31** : 420-22.

DISEASES OF COTTON IN BOMBAY

I. ALTERNARIA LEAF-SPOT

M. S. Rane and M. K. Patel
(Accepted for publication May 21, 1956)

Introduction

Cotton is the most important cash crop in Bombay State having the largest acreage (3,871,420 acres in 1951-52) in the Indian Union. The species commonly cultivated in the state are *Gossypium herbaceum* L. in Gujarat, *G. arboreum* L. in Khandesh and *G. herbaceum* and *G. hirsutum* L. in Bombay Karnatak. As the area under cotton was reduced by about 50 percent on account of the "Growth of Food Crops Act", a deficit of the medium and long staple cotton was felt by the mills. To remedy it without any reduction in the enhanced acreage under food crops, tree cotton, commonly grown on marginal land and in the transitional and heavy rainfall belts, was being tested for its suitability for extension in Bombay-Karnatak. Since the last 5-6 years, long staple *hirsutum* cotton (variety Co4-B-40) has also been introduced in the Deccan canal tract to make up the shortage.

In early October, 1948, a severe leaf-spot caused by *Alternaria* sp. was noticed on tree cottons at Dharwar. In successive years, the disease was also reported from Poona and Ahmednagar districts on the newly introduced variety Co4-B-40. It assumes serious proportions under high humidity commonly available in the Deccan canal tract.

Symptoms

Alternaria leaf-spot is of great importance in the case of tree cotton yield of which is affected by nearly 10 to 15% under severe attack. The infected leaves drop causing defoliation which is more responsible for the loss in the case of *hirsutum* and tree cottons, normally not a natural phenomenon. In very severe cases, the stems and bolls are also affected.

In nature, the disease appears on leaves as small, round to irregular, pale to dark brown spots, measuring 0.5 to 3 mm. in diameter with cracked centre. They are raised on the upper surface and depressed on the lower. Dark brown crustation is found on both the surfaces. Some times, the leaf-veins also get infected. In severe cases of infection, the spots coalesce forming irregular patches, spreading all over the leaf lamina including the edges (Fig. 1- B,C & D Page 113). The infected leaves dry up and shed. In rare cases, the stem is found infected with semicircular crescent-like scars and the centre cracking vertically (Fig. 1-A Page 113). In most severe cases, bolls get infected and shed. Under artificial conditions, fair infections was produced on bolls.

Infection Experiments

A number of isolations made in the usual manner yielded *Alternaria* sp. which was used for further studies.

This disease occurs from August to November when high humidity and moderate temperature prevail. Under the artificial conditions of infection, the plants kept under moist chamber with frequent spray of sterile water gave better and quicker infection than those kept under comparatively dry conditions.

The viability and pathogenicity of the fungus in naturally infected leaves tested by periodical isolation for 12 months ending December, 1953 conclusively showed it to be capable of over-summering and serving as primary source of infection the following season.

The earliest symptoms of infection appeared 4 days after inoculation when small, pale brown, round spots were observed. After 7 days, the disease was well advanced. The control plants remained healthy. A comparison of the symptoms produced in the artificially infected plants with those occuring under the natural conditions showed close similarities.

Infection experiments under the most optimum conditions have shown that *G. arboreum*, *G. herbaceum*, *G. hirsutum* and *G. barbadense* are susceptible whereas plants belonging to Malvaceae such as *Abutilon indicum* Sweet, *Althaea rosea* Cav., *Hibiscus cannabinus* L., *H. esculentus* L., *H. sabdariffa* L., *H. sabdariffa* var. *altissima* L., *H. tetraphyllus* Roxb., *Sida rhombifolia* var. *retusa* L. gave negative results.

Of the *Gossypium* spp., the following varieties viz., Kidney cotton, Sakel and Sea Island belonging to *barbadense* group; Moco belonging to *purpurescens* group; Co4, Jinjiya, 4411, Co2, L. S. S., M4, Perso-American, Kampala and 4F-98 belonging to *hirsutum* group; B. D. 8, G. E. 5, Vijay, W. J. 197, R. K. 19, K. F. and Jaydhar belonging to *herbaceum* var. *frutescens* group and N. M. D., Dhulia-2, N. R. 5, belonging to *arboreum* var. *neglectum* group show moderate to severe infection. Persian, Baluchistan and Russian selections belonging to *herbaceum* var. *typicum* group, Cutch wagad and Wagad selections, Seg. 8-1, G. A. 26, 1027 A. L. F., N. S. 12 and Hagari belonging to *herbaceum* var. *frutescens* group; Jarila, Virnar, Chinese R-1, Dokras, Gaorani-6 and Gaorani-12 belonging to *arboreum* var. *neglectum* group showed slight infection whereas Rozi belonging to *arboreum* var. *typicum* group showed a trace and Red Arboreum belonging to *arboreum* race *bengalense* group was immune.

A comparison of the above results regarding relative reactions of the various varities of cotton to *Alternaria* leaf-spot with those obtained by Patel and Kulkarni (1950) for black arm disease of cotton shows a corresponding correlation as regards their relative resistance to these two diseases.

Morphology

The following observations were made on a two week old culture of the fungus grown on potato dextrose agar at 27° C.:-

Mycelium:- The fungus produces profuse mycelial growth in potato dextrose, Richards', Oatmeal, host decoction dextrose and synthetic agars. The young mycelium is aerial, hyaline, septate and irregularly branched turning light grayish brown when old. In old cultures, the mycelium is dark brown near the substratum; the average width of hyphae is 6.2μ. Branching is at acute angles. H-shaped structures between two hypae are also observed though these are not of general occurrence.

Conidiophores:- The conidiophores are short or long, dark brown and bear a single conidium at the apex. In most cases, the conodiophores are straight, erect or irregularly bent and slightly constricted at the septa, geniculate with swollen basal cell with terminal scar at the point of attachment of the conidium. They measure 39-132 x 5.8 - 8.9 μ with 1 to 8 septa.

Conidia:- In culture, the conidia measure 14. 1-55.7 x 7.1.-24.5 μ (average being 34.4 x 13.3 μ) without beak, and 22.7 - 126.0 x 7.1 - 24.5 μ (average being 51.0 x 13.3 μ) including the beak (Fig. 1-E 113). The beak measures 6.3 to 73.2 μ (average 16.6 μ) in length. The conidia have 3 to 9, usually 4 to 6, transverse and 0 to 4, usually 2, longitudinal septa. The transverse walls can be made out easily by constriction except in the beak region. They are light to dark brown, obclavate to muriform, having a round base and tapering gradually to the apex which may be drawn into a septate or non-septate beak. Sometimes, an individual conidium develops a large number of longitudinal and transverse septa forming an irregularly shaped muriform spore.

The conidia obtained from the leaf measure 37.8 - 61.1 x 14.8 - 20.2 μ (average 46.5 x 16.9 μ) without beak, and 79.9 - 177.8 x 14.8 - 20.2 μ (average 106.2 x 16.9 μ) with beak which measures 34.9 - 126.6 μ (average 59.7 μ) in length. These conidia have usually 4 to 6 transverse and 2 to 5 longitudinal septa (Fig. 1-F). They are relatively slightly bigger and the beaks longer than those obtained from the culture.

Cultural Characters

The germination of the conidia and the growth of the fungus are the best at 26–27° C. and nil at 0 and 40° C.

The fungus makes the best growth in Richards' agar although it grows fairly well on other media except on plain agar where the growth is flat and poor. Sporulation is generally scanty except in Brown's synthetic and host decoction dextrose agars.

The fungus produces profuse growth and abundant sporulation on inulin agar whereas it makes fair to good growth on asparagin rosolic acid,

amygdalin, starch, gelatin, egg albumen agars with no or scanty sporulation, and poor growth with no sporulation on cellulose and casein agars.

The fungus makes good growth in almost all the carbon compounds viz. glucose, galactose, levulose, maltose, sucrose, lactose, dextrin, dextrose, raffinose, amygdalin, glycogen and inulin and flat, filamentous growth in arabinose, salicin and mannitol. Sporulation is scanty in most cases except in inulin where it is abundant. In general, the fungus makes use of a wide range of carbon sources as expressed by vegetative growth.

The fungus grows profusely on ammonium tartarate, potassium nitrate, sodium nitrate, peptone, creatine, tryptophane, glycine, asparagin and arginine, whereas on ammonium nitrate, ammonium phosphate and guanidine hydrochloride, growth is fair.

The fungus can grow in a wide range of H ion concentrations, but growth decreases in media with high acidity and alkalinity. The range of optimum reaction lies between pH 4.8 and 5.2. In general, the amount of mycelial mat produced is more in acid than in alkaline reaction.

General Discussion, Taxonomy and Nomenclature of the Fungus

Various species of *Alternaria* causing diseases of cotton such as leaf-spot, boll rot, twig blight and stem canker have been described from different countries. Thus, Faulwetter (1918) described a leaf spot of cotton from South Carolina and ascribed to it *A. tenuis* Nees. on the basis of its spore measurements and characters. Burmingham and Hamilton (1923) from New South Wales, Jehle and Wood (1925) from different parts of U.S.A., Laycock (1926) from South Nigeria, Kvashnina (1928) from North Caucasus and several other workers reported diseases caused by *Alternaria* sp. on cotton but did not mention the species concerned. Hopkins (1931) working with a leaf-spot and boll rot of cotton in South Rhodesia thought the fungus causing the disease to be new and identified as *A. gossypina* (Thum.) Hopk. Biraghi (1937) reported *A. macrospora* causing boll rot of cotton in Italy and also isolated *A. gossypinum* Thum. from the carpels. According to him, all species of *Alternaria* causing leaf-spot in cotton belong to *A. macrospora* which has also been reported from Trinidad (Jones,1928), Bombay (Uppal, Patel and Kamat, 1935), and China (Ling and Juhwa 1941). The four species of *Alternaria* that have been attributed so far to cause various types of diseased condition in cotton are *A. tenuis*, *A. gossypinum*, *A. macrospora* and *A. gossypina*. The Bombay fungus under study is clearly distinct from *A. tenuis* not only on the basis of morphological characters but also of cultural behaviour and pathogenicity and is very closely allied to the latter three species.

A comparison of the Bombay *Alternaria* with the three species cited abov with regard to the etiology of disease, spore measurements and characters, cultural behaviour, host reactions and virulence (Table 1) would clearly place it with *A. macrospora* with which it closely resembles in all respects except its reactions on different varieties and species of *Gossypium*. Ling and Juhwa (1941) reported a closely allied leaf-spot and stem blight of

TABLE 1

A comparison between various species of *Alternaria* on cotton

	Spore measurements in μ		Nature of disease	Authority
	Without beak	With beak		
1	2	3	4	6
Alternaria tenuis Nees	22 to 35 (?) x 6–13	—	Leaf - spot	Faulwetter (1918)
A. gossypina (Thum.) Hopkins	32–46 x 12–15	41–98 x 12–15	Leaf-spot and boll rot	Hopkins (1931)
A. gossypinum (Thüm.)	7–44 x 6–13	11–56 x 6–13	Boll rot	Biraghi (1937)
A. macrospora Zimm.	—	150–170 x 20	Leaf - spot	Zimmermann (1904) (Abstract from Jones, 1928).
A. macrospora Zimm.	34–50 x 10–18	74–150 x 10–18 74–164 x 10–20	Leaf-spot, bud and boll rot	Jones (1928)
A. macrospora Zimm.	25–66 x 8–25 average 43 x 13	69–168 x 8–25 average 101 x 13	Leaf - spot and twig-blight	Lee Ling and Juhwa (1941)
A. macrospora Zimm.	11–44 x 7–16	14–66 x 7–16	Boll rot	Biraghi (1937)
Alternaria under study, from host	37.8–61.1 x 14.8–20.2, average 46.5 x 16.9	79.9–177.8 x 14.8–20.2 average 106.2 x 16.9	Leaf-spot	—
Alternaria under study, in culture	14.1–55.7 x 7.1–24.5. average 34.4 x 13.3	22.7–126.8x 7.1–24.5, average 51 x 13.3		

cotton in China and referred their fungus to *A. macrospora* on the basis of spore measurements and cultural behaviour. While the findings and observations made on the present fungus are in close accord with the findings of Ling and Juhwa, they differ from them essentially in rspect of the reaction of the fungus on the different species of *Gossypium*. The Chinese fungus readily infects the varieties of cotton belonging to *G. arboreum* while the Bombay fungus infects this species with difficulty, producing a highly resistant type of reaction.

The spore measurement of *Alternaria* under study being 80–177 x 15–20 μ compares very favourably with the original description of *A. macrospora* by Zimmermann where they are stated to be 150–170 x 20 μ . Neergard (1945) in discussing the status of *A. macrospora* states that Mason (1928) was unable to obtain authentic material of *A. macrospora* and that the long rostrum of the spores produced singly on conidiophores is characteristic of *A. porri*. The spores in *A. macrospora* are, however, shorter than in *A. porri*.

As regards the descriptions of *Alternaria macrospora* on cotton given by other authors, it may be stated that *A. macroposra* described by Biraghi from Italy as inciting the boll rot of cotton is a different species, since the spores are smaller in size (14–66 x 7–16 μ) and are produced in catenuations. It is quite different from *A. macrospora* with spores produced singly and possessing long hyaline beaks.

Ling and Juhwa described *A. macrospora* on *G. arboreum* from China with spores equal in size to the species under study. Mature spores are stated to be brown, obclavate, constricted at septa bearing long, hyaline, filiform beaks and measuring 69–168 x 8–25 μ. The spores compare favourably in size with that given for *A. macrospora* by Zimmermann (150–170 x 20 μ). While the Chinese fungus is shown to parasitise both *G. hirsutum* and *G. arboreum*, the species from Bombay infects *G. hirsutum*, *G. herbaceum*, *G. barbadense* and others. All attempts to inoculate other malvaceous hosts have been unsuccessful. From the general description of the fungus, the *Alternaria* species on cotton in Bombay is *A. macrospora*. The fungus is highly specialized and is shown to oversummer on infected leaves, which provide primary inoculum during the succeeding season.

Summary

The leaf-spot of cotton is widespread in various districts of Bombay State on tree cotton and Co4-B-40 variety of *hirsutum* group. The fungus does not normally cause boll-rot nor stem canker in nature. The disease is highly favoured by moderate temperatures (26-30°C.), high humidity and frequent drizzling rain. Though a virulent parasite, it is restricted to species of *Gossypium* only infecting *G. hirustum*, *G. barbadence* groups but not *G. herbaceum* and *G. arboreum* groups which show relatively high resistance.

The fungus has a wide temperature range with 5°C., 26-27°C. and 35°C. as the minimum, optimum and maximum respectively. It over-

summers in dead leaves which provide primary inoculum in the succeeding season. No collateral host outside *Gossypium* spp. has been found. It is identified as *Alternaria macrospora* Zimm. since it conforms to the original description given by Zimmermann.

Plant pathological Laboratory,
College of Agriculture,
POONA-5.

References

Biraghi, A. (1937) A mummification of cotton caused by *Alternaria*. *Boll. staz. Pat., Veg. Roma*, N. S. **17**: 475-496. (Abstract in R. A. M. 17:674-675, 1938).

Faulwetter, R.C. (1918) The *Alternaria* leafspot of cotton. *Phytopathology*. **8**:98-105.

Hopkins, J. C. F. 1931) *Alternaria gossypina* (Thum.) Comb. nov. causing a leaf-spot and boll rot of cotton. *Trans. Brit. Mycol. Soc.* **16**: 136-144.

Jehle, R. A., and Wood Jassie I. (1925) Diseases of field and vegetable crops in United States in 1925. Plant disease Reporter Supplement 45: 152. (Abstract in R. A. M. 5:398, 1926).

Jones, G. H. (1928) An *Alternaria* disease of the cotton plant. *Ann. Bot.* **42**:935-947.

Kvashnina, Mme. E. S. (1928) Preliminary report of the survey of diseases of medicinal and industrial plants in North Caucasus. *Bull. North Caucasian Plant Prot. State*, **4**:30-46 (Abstract in R. A. M. 7:763-764, 1928).

Laycock, T. (1926) Preliminary investigations of the parasitism of certain fungi causing bollrot of cotton. Fourth *Ann. Bull. agric. Dept. Nigeria*, 32-49. (Abstract in R. A. M. 5:424-425, 1926).

Ling, Lee (1944) Factors influencing the development of cotton diseases. *Ann. appl. Biol.* **31**: 199-204.

———and Juhwa Y. Yang (1941) Stem blight of cotton caused by *Alternaria macrospora*. *Phytopathology* **31**: 664-671.

Patel, M. K. and Y. S. Kulkarni (1950) Bacterial leaf-spot of cotton. *Indian Phytopathology*. **3**: 51-63.

Neergard, Paul (1945) Danish species of *Alternaria* and *Stemphylium*. Copenhagen, pp. 1-560.

Uppal, B. N., M. K. Patel and M. N. Kamat (1935) Fungi of Bombay. *Bombay Dept. Agric. Bull.* **176**.

Zimmermann, A. (1904) Berichte uber land μ. Forstwirtschaft von Deutsch ostafrika, Bd-ii, pp, 24-5 Taf. ii. (original not seen).

EXPLANATION OF FIG. I.

A. Stem infection with semicircular scar and vertical cracking.

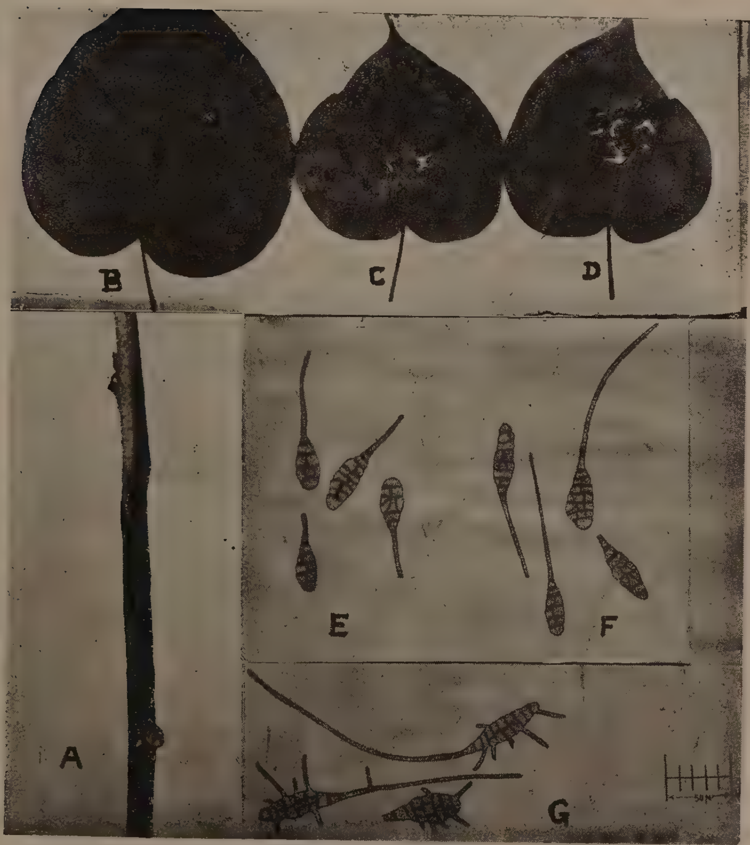
B, C & D. Different stages of leaf infection.

E. Conidia from culture.

F. Conidia from leaf.

G. Germinated conidia.

Alternaria leaf-spot of cotton



WILT DISEASE OF SHISHAM (*DALBERGIA SISSOO* ROXB).

III. Studies on Soil Fungi (Excluding *Aspergillus* and *Penicillium*) Isolated from shisham Forests.

B. K. Bakshi and Sujan Singh

(Accepted for publication May 29, 1956)

In previous publications (Bakshi, 1954; Bakshi and Sujan Singh, 1954; Bakshi, 1955), it has been shown that wilt of shisham (*Dalbergia sissoo*) caused by *Fusarium solani* is a soil-borne disease. The pathogens living in the soil are known to be influenced by their associated soil micro-organisms to the extent that their virulence on the hosts is altered. Hence in the study of root diseases of plants, we have to study the interaction between the host plant, the parasite and the general soil microflora in a varying physico-chemical habitat. It is with this view that a survey was made of the fungi present in shisham soils. So far about 50 species of fungi excluding some undetermined ones have been isolated from different shisham soils. An account of the occurence of different fungi isolated from soils of the rhizosphere and those away from the rhizosphere beneath healthy and diseased shisham trees and the effects of these fungi on *F. solani in vitro* will be communicated later. A systematic account of 19 fungi forms the subject of the present communication.

The soil fungi were isolated by the dilution plate method and established in pure culture. The cultural characters were studied on malt agar at 25 °C in dark. Colours indicated within comas were noted from Ridgway (1912). Some of the cultures have been identified or the identities of some of them confirmed at the Commonwealth Mycological Institute, Kew through the courtesy of Dr. S. P. Wiltshire and his colleagues, to whom our sincere thanks are due. All the cultures are deposited in the culture collection at the Mycology branch of the Forest Research Institute, Dehra Dun.

Absidia butleri Lendner

Colonies fast growing, growth 2.5–2.7 cms., white to creamy white, cobwebby; stolons brown, long, branched; sporangiophores hyaline, brown with age, branched, in groups of 1–5 (text-fig. la), septate, 50-490 x 1.7–2.8 μ; apophysis well defined, thickwalled, globose to oblong (text-fig. lb), 3.2–8.8 x 2.9–8.0 μ; sporangia hyaline, thin or thick-walled, pyriform (text-fig. lc), 10.2–25.6 x 10.2–22.4 μ; columella brown, smooth, persistant after the discharge of the spores (text-fig. lb), 2.9–8.5 x 1.5–8.5μ; sporangiospores hyaline, round, oval to oblong (text-fig. ld), 1.7–4.9 x 1.4–4.3μ; chlamydospores hyaline, few, present in old cultures (text-fig. le), 9.6–12.8μ in diameter; zygospores formed in one isolate, dark brown, 16 - 60μ broad, with appendages on both suspensers (text-fig. lf); appendages brown, septate, 48–170 x 3.8–5.8 μ.

Confirmed by Major Dade (C.M.I.).

Description of cultural characters: Gilman, 1950; Paine, 1927.

Absidia cylindrospora Hagem

Colonies fast growing, growth 4.2 cms., white turning grayish black with age, cobwebby; stolons hyaline when young, turning brown with age, well developed; sporangiophores hyaline, brown in the region of apophysis, branched, arising in groups of one to five from stolons (text-fig. 2a), prostrate or erect, 62–198 x 3.4–5.4 μ; sporangia hyaline, light brown with age, thick-walled, smooth, globose, 10–21 μ in diameter; columella brown, thick-walled, spherical, ending in a blunt or rounded spine (text-fig. 2b); sporangiospores hyaline, thick-walled, round to oval (text-fig. 2c), 2.9–4.6 x 2.1 2.9 μ; zygospores not observed.

Identified by Major Dade (C.M.I.)

Description of cultural characters: Gilman, 1950; Waksman, 1917.

Acrothecium lunatum Walker

Colonies fast growing, growth 2.7 cms., white when young, soon becoming grayish black ('dark olive gray'), felty with loose aerial cottony mycelium; conidiophores brown, 0.1–0.6 mm. long, 3.3–5.3 μ broad; conidia brown, borne in whorls of 3–7, usually 3-septate, rarely 0–2 septate, irregularly oblong, third cell from the base largest and conidium having a curvature at this place (text-fig. 3a), 17.5–25.6 x 9.9–13.5 μ; chlamydospores intercalary, thick-walled, (text-fig. 3b).

Description of cultural characters: Chaudhuri and Sachar, 1934; Galloway, 1936; Gilman, 1950.

Alternaria humicola Oudemans

Colonies fast growing, growth 2.4 cms., white when young, soon becoming greenish black, margin remaining white, appressed, powdery; conidia light brownish yellow with walls brown, in chains (text-fig. 4a), smooth or pitted, 0–7 septate, slightly constricted at the septum, transversely septate or muriform, oval to oblong to obclavate to lageniform (text-fig. 4b), 8.8–46.7 x 4.7–15 μ.

Description of cultural characters: Chaudhuri and Sachar, 1934; Gilman, 1950; Swift, 1929.

Cephalosporium sp.

Colonies slow growing, growth 0.5 cm., white, condensed felty, funiculose at centre, appressed at periphery; conidiophores hyaline, long, thin (text-fig. 5a), 14 - 42 x 0.8–1.2 μ; conidia in heads, without mucus, hyaline, ovoid to cylindric to allantoid (text-fig. 5b), 3.6–5.6 x 1.3–2.6 μ.

Confirmed by Dr. Brown (C.M.I.)

Description of cultural characters: Clements and Shear, 1931; Gilman, 1950.

Cunninghamella echinulata Thaxter

Colonies fast growing, growth 5.2 cms., white, cobwebby; rhizoids pre-

sent (text-fig. 6a); conidiophores hyaline, erect, 0.4–1.4 mm. long, 7.1–8.8μ wide; vesicles hyaline, nearly globose (text-fig. 6b), terminal vesicles nearly of the same size as the lateral vesicles, 15.6–39.8 x 12.8–34.1 μ; conidia attached to the vesicle by stalks, hyaline, echinulate, round to ovoid (text-fig. 6c), 9.2-17.0 x 9.2 – 14.9μ.

Description of cultural characters: Alcorn and Yeager, 1938; Gilman, 1950.

Cunninghamella verticillata Paine

Colonies fast growing, growth 4.0 cms., white when young, light buff with age; conidiophores erect, 2–3 mm. long, bearing a subterminal whorl of 1–5 branches (text-fig. 7a), swollen at the point of attachment of branches, branches upto 30μ long, terminated by a vesicle; vesicles hyaline, globose to pyriform, terminal vesicles larger, 38.4–60.8 μ, lateral vesicles smaller, 19.2–32.0 μ in diameter; conidia hyaline when young, turning brown with age, attached to the vesicle by stalks, 2.8–4.9 μ long, globose to oval, finely echinulate (text-fig. 7b), 8.5–16.0 μ in diameter, when conidia are discharged stalks seen rarely on vesicles which in most cases are smooth.

Description of cultural characters: Alcorn and Yeager, 1938; Chaudhuri and Sachar, 1934; Gilman, 1950; LeClerg, 1930.

Geotrichum sp.

Colonies fast growing, growth 3.2 cms., hyaline, appressed, aerial mycelium lacking, conidiophores short or obsolete (text-fig. 8a); conidia hyaline, in chains, cylindric (text-fig. 8b), 3.7–7.4 x 2.8–5.0 μ.

Confirmed by Dr. Ellis (C.M.I.)

Description of cultural characters: Clements and Shear, 1931; Gilman, 1950.

Gliocladium catenulatum Gilman and Abbott

Colonies moderately growing, growth 2.0 cms., light gray in patches, white when young becoming 'salmon buff' and then smoky gray', light green and light pink areas also appearing with age, plumose; conidiophores arise usually from funiculose hyphae, septate, branching 2–4 times (text fig. 9a), ultimate branches bear a whorl of stalks bearing conidia in heads; conidia hyaline, enclosed in mucus, globose to ovoid (text-fig. 9b), 2.8–5.7x 2.1–3.1μ.

Identified by Dr. Brown (C.M.I.).

Description of cultural characters: Gilman, 1950.

Gliocladium penicilloides Corda

Colonies slow growing, growth 0.5 cm., white to creamy white, cobwebby, appressed at portions; conidiophores hyaline, 135–326 x 2.8–4.2μ; phialides and conidia enclosed in mucus and appear under low power as globular mucilaginous balls; phialides hyaline, in two, rarely in three series (text-fig. 10a), primary phialides 13–26 x 1.4-1.8μ, secondary 11–28 x 1–1.4μ;

conidia hyaline, in chains which are not distinguishable due to their being enclosed in mucus, globose to ovoid to bacillate (text fig. 10b), 1.6–4.5 x 1.1–1.8 μ.

Description of cultural characters: Gilman, 1950.

Gonytrichum macrocladum (Sacc.) Hughes

Colonies slow growing, growth 0.3cm., blackish green ('dark olive gray') at 30° C., sepia ('fuscus') at 18° C., appressed to sub-felty; conidiophores septate, branched with 1–4 lateral branches at the septum (text-fig. 11a and 11b), 72–500 x 3.5–5.7 μ; lateral branches 1–2 septate (text fig. 11a); conidia pale green, in heads enclosed in mucus, smooth, ovoid (text-fig. 11c), 4.3–4.7 x 2.7–3.0 μ.

Identified by Dr. Ellis (C.M.I.).

Description of cultural characters: Clements and Shear, 1931; Huges, 1951.

Haplographium chlorocephalum (Fresenius) Grove

Colonies slow growing, growth .3cm., bluish gray ('dark olive gray', 'olivaceous black' to 'castor gray'), appressed; conidiophores brown, short with terminal whorl of phialides (text-fig. 12a); phialides light brown, usually in one series, rarely in two (text-fig. 12b), primary phialides 3.5–6.8 x 2.6–3.6 μ, secondary 3.9–6.4 x 2.6–3.5 μ; conidia in chains, greenish brown, ovoid with short ends flattened (text-fig. 12c), 3.5–5.7 x 2.8–4 μ.

Description of cultural characters: Gilman, 1950.

Hormodendrum viride (Fresenius) Saccardo

Colonies slow growing, growth 0.3 cm., green ('vetiver green') when young, 'deep olive' with age, thin, powdery; conidiophores cylindric with narrow ends (text fig. 13a and 13b), without phialides, 56–230 x 3.3–4 μ; conidia in dendroid chains, greenish yellow, ovoid to cylindric (text-fig. 13c) 4.4–10 x 2.1–3.5 μ.

Description of cultural characters: Bisby, Timonin and James, 1935; Gilman 1950; Paine, 1927.

Humicola fusco-atra Traaen

Colonies slow-growing, growth 1.1 cms., hyaline, appressed but cottony to cobwebby over the inoculum, hyphae hyaline, much branched; conidia pleurogenous, borne directly on hyphae (text-fig. 14a), or acrogenous borne terminally on conidiophores (text-fig. 14b), hyaline when young, brown with age, thick-walled, round to oval (text fig. 14b), 4.4–8.5 x 5.4–5.7 μ; chlamydospores intercalary (text fig. 14c), rare.

Identified by Dr. Ellis (C.M.I.).

Description of cultural characters: Saccardo, 1931.

Humicola sp.

Colonies moderately growing, growth 2.0 cms., hyaline, appressed, aerial mycelium lacking; conidiophores extremely short or apparantly looking; conidia both pleurogenous and acrogenous, hyaline, globose, thick-walled (text-fig. 15a and 15b), 13–24 μ; chlamydospores hyaline, intercalary (text-fig. 15c), 16–25.6 x 15.4 – 19.5 μ.

Identified by Dr. Ellis (C.M.I.) who remarks 'We have nothing like this in Herb. C.M.I."

Description of cultural characters: Saccardo, 1931.

Paecilomyces sp.

Colonies slow growing, growth 0.6 cm., white, plumose; conidiophores arise from plumose hyphae, slender (text fig. 16a), fall off easily, 20–30 x 1.3–2.6 μ; conidia in chains, hyaline, wall minutely rough, globose to ovoid, slightly apiculate (text-fig. 16b), 2.6–4.4 x 2.6–3.3 μ; chlamydospores hyaline, terminal and intercalary (text-fig. 16c), 5.7–8.8 x 2.8–5.7 μ.

Identified by Dr. Brown (C.M.I.).

Description of cultural characters: Gilman, 1950.

Papularia sphaerosperama (Pers. ex. Fr.) V. Hohnel.

Colonies slow growing, growth 0.2 cm., white, conidial areas 'deep grayish olive', appressed-felty; conidiophores small (text-fig. 17a), hyaline, sometimes 'deep grayish olive'; conidia hyaline when young, 'grayish olive' with 'deep grayish olive' wall on maturity, occurring singly on the tips of conidiophores, double walled, formed abundantly at 18° C. but apparently lacking at 30° C., globose to ovoid (text-fig. 17b), 7.8–11.6 x 5.7–11.6 μ.

Identified by Dr. Ellis (C.M.I.).

Description of cultural characters: Gilman, 1950; Hughes, 1951

Rhizopus nigricans Ehrenberg

Colonies fast growing, growth 9 cms., white, turning gray due to the formation of sporangia, cobwebby with abundant long aerial hyphae; rhizoids light brown, abundant (text-fig. 18a); sporangiophores borne on stolons just opposite rhizoids in groups of 3–5 or more (text-fig. 18a), rarely single, 0.3 – 0.5 mm. long and 11–19μ wide; sporangia at first hyaline, later turning black, globose (text-fig. 18b), wall evanescent, 113–178 μ; columella round but becomes shrunken after the rupture of the sporangial wall, 35–77 x 25-73 μ; conidia light brown, round to oval (text-fig. 18c), 5.4–8.5 x 4–8.2 μ; zygospores (text-fig. 18d) brown to black, abundant, verrucose, suspensors swollen (text-fig. 18d), 149–213 x 127–170 μ.

The present species resembles with *Rhizopus nigricans* Ehrenb. var. *minutus* Chaudhuri and Sachar (Chaudhuri and Sachar, 1934).

Description of cultural characters: Bayliss-Elliott, 1930; Chaudhuri and Sachar, 1934; Gilman 1950; Le Clerg, 1930, 1931.

Trichoderma viride Pers. ex Fries

Colonies fast growing, growth 4.9 cms., white at first soon turning light green which represent conidial areas; conidiophores not distinct from vegetative hyphae, indefinite in length, di or tri-chotomously branched; phialides (text-fig. 19a), 5–11.6 x 1.7–2.6 μ; conidia borne in groups of two to four held together in mucilage in persistant heads which are 6–8 μ in diameter, sometimes the adjoining heads fuse together to form a larger head, pale green-brown tinge, slightly thick-walled, smooth, globose (text-fig. 19b), 2.4–3.7 μ or more commonly ovoid, 3.2–4.6 x 2.6 – 3μ.

The fungus resembles with *T. koningi*. Bisby (1939), however, considers that the various cultures of *Trichoderma* represent one variable species and that *T. viride* Pers. ex Fries is the type species of the genus. Following this view the present isolate is named *T. viride*.

Description of cultural characters: Bisby 1939, 1944.

Forest Research Institute & Colleges,
Dehra Dun.

REFERENCES

ALCORN, G. D. AND YEAGER, C. C. (1938). A monograph of the genus *Cunninghamella* with additional description of several common species. *Mycologia*, **30** : 653–658.

BAKSHI, B. K. (1954). Wilt of shisham (*Dalbergia sissoo* Roxb.) due to *Fusarium solani*. sensu Snyder and Hansen. *Nature*, **174**, 278.

——————(1955). Wilt disease of shisham (*Dalbergia sissoo* Roxb.) II. Behaviour of Fusarium solani, the wilt organism, in soil. *Indian Forester*, **81**, 276-281.

—————— AND SUJAN SINGH (1954). Wilt disease of shisham (*Dalbergia sissoo* Roxb.) I. Introduction and host-parasite relationship. *Indian Forester*. **80**, 316–322.

BAYLISS-ELLIOTT, J. S. (1930). The soil fungi of the Dover salt marshes *Ann. App. Biol.*, **17**: 284–305.

BISBY, G. R. (1939). *Trichoderma viride* Pers. ex Fries and notes on Hypocrea *Trans. Brit. mycol. Soc.*, **23**, 149–168.

——————(1944). Notes on British Hyphomycetes. *Trans. Brit. mycol. Soc.*, **27** : 101–112.

BISBY, G. R., TIMONIN, M. AND JAMES N. (1935). Fungi isolated from soil profiles in Manitoba. *Canad, J. Res.* C. **13** : 47–65.

CHAUDHURI, H. AND SACHAR, G. S. (1934). A study of the fungus flora of the Punjab soils. *Ann. Myc.*, **32** : 90–100.

CLEMENTS, E. F. AND SHEAR, L. C. (1931). The genera of fungi, New York.

GALLOWAY, L. D. (1936). Indian soil fungi. *Indian J. Agric. Sci.* **6**: 578–585.

Gilman, C. Joseph (1950). A manual of soil fungi, Iowa.

Hughes, S. J. (1951). *Stachylidium, Gonytrichum, Mesobotrys, Chaetopsis* and *Chaetopsella*. *Trans. Brit. mycol. Soc.*, **34** : 551–576.

LeClerg, E. L. (1930). Cultural studies of some soil fungi. *Mycologia* **22** : 186–210.

———(1931). Distribution of certain fungi in Colorado soils. *Phytopathology*, **21** : 1073–1081.

Paine, F. S. (1927). Studies on the fungus flora of virgin soils. *Mycologia*, **19** : 248–266.

Ridgway, R. (1912). Color Standard and Color Nomenclature, Washington.

Saccardo, P. A. (1931). Sylloge Fungorum, **25** : 650.

Swift, M. E. (1929). Contribution to a mycological flora of local soils. *Mycologia*, **21** : 204–221.

Explanation of Text Figures

Fig. 1. *Absidia butleri.* a, sporangiophores; b, apophysis (below) and columella (above); c, sporangium; d, sporangiospores ; e, chlamydospores; f, zygospore; a - c, e - f

Fig. 2. *Absidia cylindrospora.* a, sporangiophores; b, columella; c, sporangiospores; a b - c

Fig. 3. *Acrothecium lunatum.* a, conidia; b, chlamydospores, all

Fig. 4. *Alternaria humicola.* a, conidial chain; b, conidia; a b

Fig. 5. *Cephalosporium* sp. a, conidiophores; b, conidia, all

Fig. 6. *Cunninghamella echinulata.* a, rhizoids; b, vesicles with conidia; c, conidia; a b - c

Fig. 7. *Cunninghamella verticillata.* a, conidiophores with lateral branches and terminal and lateral vesicles; b, conidia, all

Fig. 8. *Geotrichum* sp. a, conidiophore; b, conidia; all

Fig. 9. *Gliocladium catenulatum.* a, conidiophore b, conidia; all

Fig. 10. *Gliocladium penicilloides.* a, conidiophore with phialides; b, conidia; all

Fig. 11. *Gonytrichum macrocladum.* a, conidiophores with lateral branches and conidial head; b, conidiophores with conidial head; c, conidia; a and c b

Fig. 12. *Haplographium chlorocephalum.* a, conidiophores; b, phialides; c, conidia; all

Fig. 13. *Hormodendrum viride.* a, conidiophores with dendroid chains of conidia; b, detached conidiophores; c, conidia; a b - c

Fig. 14. *Humicola fusco-atra.* a, pleurogenous conidia; b, acrogenous conidia; c, chlamydospore; all

Fig. 15. *Humicola* sp. a, pleurogenous conidia; b, acrogenous conidia; c, chlamydospores; a b - c

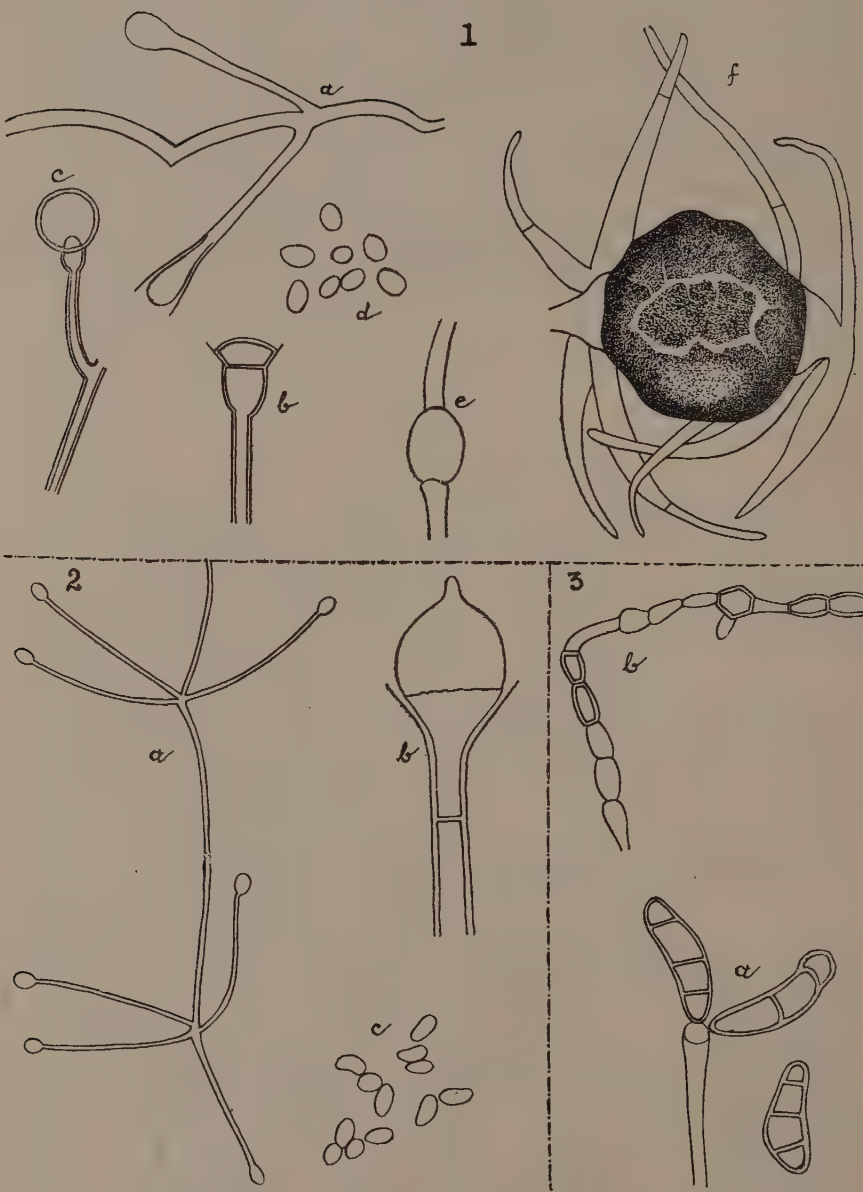
Fig. 16. *Paecilomyces* sp. a, conidiophores; b, conidia; c, chlamydospore; a b - c

Fig. 17. *Papularia sphaerosperma.* a, conidiophore; b, conidia; all

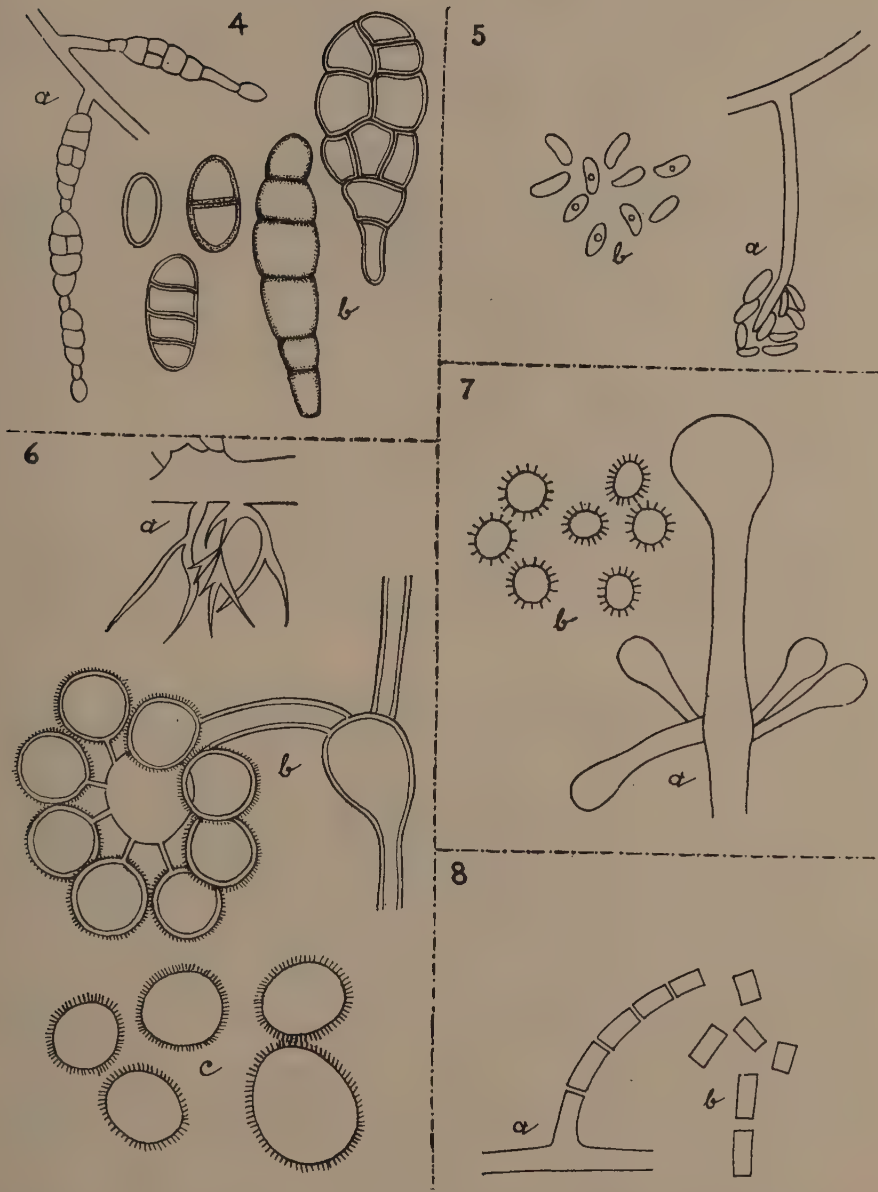
Fig. 18. *Rhizopus nigricans.* a, sporangiophores and rhizoids; b, sporangium; c, conidia; d, zygospore; a - band d c

Fig. 19. *Trichoderma viride.* a, phialides; b, conidia; all

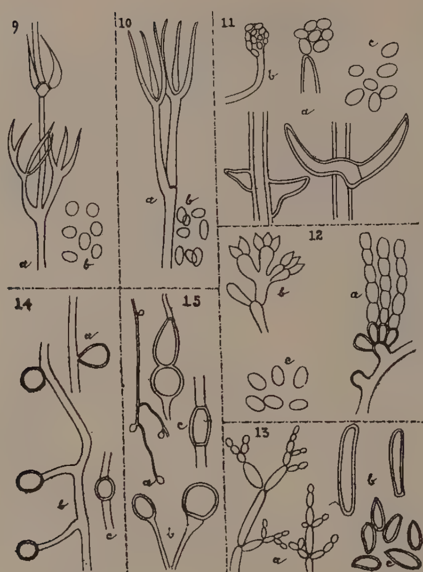
TEXT FIGURES

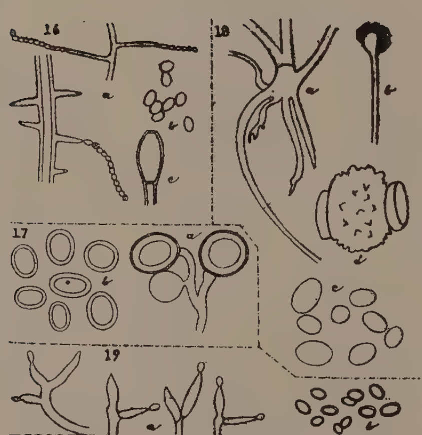


TEXT FIGURES



TEXT FIGURES





NOTES ON MISCELLANEOUS INDIAN FUNGI. IV

B. L. Chona, R. L. Munjal and J. N. Kapoor

(Accepted for publication May 21, 1956)

The paper is the fourth of the series. The first of the series appeared in *Indian Phytopath.* Vol. 3, 1950 and the second in Vol. 8, 1955 and third in Vol. 9, 1956, of the same Journal. This paper gives an account of 17 fungi, which are either new records or new host records for India and 5 of these species are new to science. Type specimens of the new species have been deposited in Herb. Crypt. Ind. Orient. I. A. R. I., New Delhi.

59. *Karschia prinsepiae* sp. nov. (Fig. 1)

Spots black, circular, separate, upto 10 mm. in diameter with loose superficial hyphal weft appearing as subicle; *Apothecia*, numerous, gregarious and superficial on the subicle, at first completely closed, globose, carbonaceous, charcoal black with dark brown septate appendages, later becoming obclavate to obpyriform with convex apex, finally the apex gets depressed giving them a true shape of apothecia; *Asci* clavate, 8-spored, 60-70 μ long and 10-14 μ broad, paraphysate; *Paraphyses* hyaline and filiform, measuring 80-90 μ long and 2-3 μ broad; *Ascospores* biseriate, bicelled, fusoid, slightly constricted at the septum, light olive brown, measuring 10–14 x 6–7 μ.

On living twigs and stem of *Prinsepia utilis* Royle, Flowerdale, Simla (Punjab), May 1955, V.C. Lele.

Karschia prinsepiae spec. nov.

Maculae nigrae, circulares, separates, 8–10 mm. diam., textu hyphali superficiali laxo. Apothecia plurima, gregaria, superficialia, primo, penitus clausa, globosa, carbonacea, nigra ornata appendicibus fusce brunneis septatisque, tum evadentia obclavata vel pyriformia apice convexo; tandem apice depresso vera apotheciorum forma apparet. Asci clavati, octospori, 60–70 μ longi, 10–14 μ lati. Paraphyses hyalinae, filiformes, 80–90 μ longae, 2–3 μ latae. Ascosporae biseriatae, bicellulatae, fusiformes, tenuiter constrictae ad septum pallide olivaceo brunneae. magnit. 10–14 x 6–7 μ.

In surculis viventibus atque in *Prinsepiae utilis* in loco Flowerdale, Simla, (Punjab), mense maio 1955 (V. C. Lele). Typus positus in Herb. Crypt. Ind. Orient. I.A.R.I., New Delhi.

The host occurs in himalayan regions of India exclusively and no member of the genus *Karschia* has been recorded on it, therefore it is proposed as a new species.

60. *Cryptomyces quercus* sp. nov. (Fig. 2)

Stroma epiphyllous, irregular, dull black, minute upto 1 mm. in length, raised and appressed to the leaf surface; loculate, dehiscing irregularly; covering membrane black, opaque, 0– 5 μ thick; Hypothecium well developed, hyaline, 10–15 μ thick; *Asci*, 8–spored, cylindric to clavate, 100–110 μ long and 12–15 μ broad, paraphysate; *Ascospore* uniseriate, elliptic to spherical, unicellular, measuring 20–23 x 12–14 μ; Paraphyses numerous, hyaline and fiilform.

On living leaves of *Quercus incana* Roxb., Glen. Simla (Punjab), 7–7–1955 (Girdhari Lal).

Cryptomyces quercus spec. nov.

Stroma epiphyllum, irregulare, obscurate nigrum, minutum, usque 1 mm. longum, elevatum atque adpressum paginae folii, loculatum, irregulariter dehiscens; membrana operiens nigra, haud translucida, 20–25 μ crassa. Hypothecium tenue, hyalinum, 10–15 μ. crassum. Asci paraphysati, octospori, cylindrici vel clavati, 100–110 μ longi, 12–15 μ lati;. Ascosporae hyalinae, haud septatae, ellipticae vel sphaericae, 12–14 x 20–30 μ paraphysibus plurimis, hyalinis, filiformibus.

In foliis viventibus *Quercus incanae*, Glen. Simla (Punjab) 7 julii 1954 (Girdhari Lal).

Saccardo has recorded 12 species of the genus *Cryptomyces*, but none on this host or other members of the family *Fagaceae*. The species described above differs from the other known species in the size of the asci and ascospores.

61. *Mycaureola indica* sp. nov. (Fig. 3)

Spots amphigenous, circular, orange to deep orange coloured; *Perithecia* epiphyllous, completely embedded in the mesophyll with a distinct protruding beak, globose, 140-280 μ in diameter; Perithecial wall bright orange, upto 35 μ thick, *Asci* cylinderic, paraphysate, 8 spored, 70-90 μ long and 10-12 μ broad; *Paraphyses* hyaline and filiform; *Ascospores* uniseriate, unicellular, hyaline, round to oval, measuring 10-12 x 6-7 μ.

On living leaves of an undetermined tree (Angiosperm), Mahabaleshwar (Bombay), 2-8-1954 (D. P. Misra).

Mycaureola indica spec. nov.

Maculae amphigenae, circulares, aurantiacae vel fusce aurantiacae. Perithecia epiphylla, penitus immersa in mesophyllo foliorum, rostro protruso, globosa, distincto rostro ornata, 140-280 μ diam. Parietes perithecii lucide aurantiaci, usque ad 3.5 μ crassi. Asci cylindrici, octospori, 70-90 μ longi, 10-12 μ lati, paraphysibus hyalinis, filiformibus. Ascosporae unrseriatae, unicellulares, hyaliniae, rotundae vel ovatae, 10-12 x 6-7 μ.

In foliis viventibus cuiusdam arboris indeterminati, Mahableshwar, die 2 augusti 1955 (D. P. Misra).

This species with its persistent innate habit and bright coloured perithecia, undoubtedly belongs to the genus *Mycaureola* of the Hypocreales. This genus was created by Maire and Chemin in 1922 with *M. dilseae* on *Dilsea edulis* (a marine alga) as Type species. Since then no other species belonging to this genus has been reported. The species described above differs widely from the earlier Type species, in the size of spores, asci, perithecia and substrate.

62. *Puccinia atropuncta* P. and C., Peck. in *Bot. Gaz.* **4** : 171, 1879; as *Aecidium dendelionis* Schw., in *Schr. Nat. Ges. Leipzig.* **1** :66, 1822.

On living leaves and stems of *Prenanthes brunoniana* Wall., Catchment area, Simla (Punjab), 17–6–1955 (J. N. Kapoor).

Pycnia amphigenous in groups; *Aecia* also amphigenous and in groups, cupulate; *Aeciospores* globoid, 12–20 x 15–20 μ, wall hyaline, upto 1.5μ thick, finely verrucose.

63. *Puccinia pacifica* Blasd., Arthur, *Bull. Torrey Club*, **48** : 31, 1921.

On living leaves of *Plantago tibetica* Hook. f. & Thoms., Mattiana (8,500 ft., Simla hills), 5–5–1955 (J. N. Kapoor).

Uredia amphigenous, dark chestnut brown. *Uredospores* ellipsoid to obovate. 20–25 x 25–30 μ; wall Chestnut brown, 2–3 μ thick, echinulate. *Telia* not seen.

64. *Frommea obtusa* (Str.) Arth., in *Bull. Torrey Club*, **44** : 503, 1917.

On living leaves of *Potentilla fragarioides* L., Naldera Golf Course (6500 ft. Simla Hills), 9–11–1954 (V. C. Lele).

Uredia hyphyllous, scattered with a few peripheral paraphyses; *Uredospores* globoid or obovoid measuring 12–18 x 16–24 μ. wall pale yellow, upto 1.5 μ thick , finely echinulate; *Telia* hypophyllous, scattered; *teliospores* cylindric clavate measuring 20–28 x 42–90 μ, 2–7 celled, rounded at the apex, wall cinnamon brown, upto 2 μ thick at sides and upto 8 μ thick at the apex, smooth; pedicel colourless measuring one half to full length of the spore.

65. *Septoria cestri* (Mont.) Sacc. in *Syll. Fung.* **3** : 498, 1884.

On living leaves of *Cestrum aurantiacum* Lindl., Darjeeling (West Bengal) 4–3–1955 (Girdhari lal).

Spots amphigenous and circular with a dark coloured border; Pycnidia epiphyllous, globose and depressed; *Pycnospores* acicular, straight to slightly curved, measuring 20–30 μ in length, mostly aseptate rarely one septate.

This fungus resembles *S. cestri* in all respects except in having a few septate spores.

66. *Septoria clematidis-flammulae* Roum. in *Revue Mycology* **5** : 178, 1883: Saccardo in *Syll. Fung.* **3** : 524, 1884.

On living leaves of *Clematis* sp., Catchment area, Simla (Punjab), 17–6–1955 (J. N. Kapoor).

Spots numerous, minute, circular, reddish, with dark purple margin, visible on both the surfaces of the leaf. *Pycnidia* epiphyllous and globose; Pycnospores curved, measuring 21–35 x 2–3 μ with 2 to 3 septa.

67. *Septoria desmezierii* Sacc. in *Syll. Fung.* **3** : 491, 1884.

On living leaves of *Hedera* helix L., Simla (Punjab), 18–6–1955 (J. N. Kapoor).

Spots small, 4–6 x 3–4 mm. irregular in outline, delimited by veins, scattered, visible on both sides of the leaf. *Pycnidia* epiphyllous, numerous and scattered all over the spots. *Conidia* somewhat tapering, curved and measure 17–21 μ in length. The fungus agrees with *S. desmezierii* in all respects.

68. *Septoria nabali* B. and C., in *North American Fungi* n. 438; Saccardo in *Syll. Fung.* **3** : 547, 1884.

On living leaves of *Prenanthes brunoniana* Wall, Catchment area, Simla (Punjab), 17–6–1955 (J. N. Kapoor).

Spots brownish red, circular, visible on both sides of the leaf. *Pycnidia* epiphyllous, globose and only a few in each spot. *Pycnospores* slender, flexuous, 20–35 μ long, aseptate, rarely 1–2 septate.

69. *Septoria sarcococcae* sp. nov. (Fig. 4).

Spots irregularly circular, tan coloured, surrounded by a yellowish halo, upto 3 mm. in diameter; *Pycnidia* epiphyllous, gregarious in the centre of the spot, dark brown, depressed and globose with a protruding ostiole, 110–130 μ in diameter. *Pycnospores* hyaline, straight or somewhat curved, 1–3 septate, 10–18 x 1.5–1.7 μ, borne on short, elliptic, hyaline cells of the pycnidial wall.

On living leaves of *Sarcococca pruniformis* Lindl., Glen, Simla, (Punjab), 4–5–1955 (J. N. Kapoor).

Septoria sarcococcae spec. nov.

Maculae irregulariter circulares, alutaceae, circumdatae nimbo chlorotico, 1–3 mm. diam. Pycnidia epiphylla, gregaria in medio maculae, fusca, haud translucida, depresse globosa ostiole protruso, 110–130 μ diam. Conidia hyaline, recta vel nonnihil curvata, 1–3 septata, 10–18 x 1.5–1.7 μ; insidentia cellulis brevibus hyalinis ellipticis parietis.

In foliis viventibus *Sarcococcae pruniformis* Glen. in Simla (Punjab), 4 maii, 1955, (J. N. Kapoor).

No *Septoria* species has so far been recorded on the genus *Sarcococca* (*Buxaceae*). There is only one species, namely *Spetoria negundnis* Ell. and Ev., that occurs on the genus Buxus, belonging to the same family, but it differs markedly from the species described above, in having smaller spores.

70. *Fusicladium dendriticum* (Wallr.). Fuck. var. *orbiculatum* Desm. in Desm., Exs. n. 1843; *Saccardo* in *Syll. Fung.* **4** : 345, 1886.

On living leaves of *Pyrus pashia* Ham., Mandi (Kulu Valley), June, 1955 (L. M. Joshi).

Spots circular, amphigenous, 3–4 in diameter; Fructifications numerous, covering the entire spot, olive coloured; *Conidiophores* short and in dense tufts; *Conidia* sub-pyriform, one septate, olive coloured and 15–20 μ long.

71. *Fusicladium diospyri* sp. nov. (Fig. 5).

Spots circular, upto 10 mm. in diameter, dark olivaceous brown, amphigenous, fructifications effuse, stroma subcuticular, *Conidiophores* in compact fascicles, pale olive, unbranched, 10–18 x 5–7 μ clavate to cylindric, sparingly septate; *Conidia* light pale olive, pyriform, one celled when young, later one septate, measuring 18–28 x 7–10 μ, borne singly at the tip of conidiophores.

On the living leaves of *Diospyros* kaki, Saharanpur (U.P.), June, 1955 (M. L. Seth).

Fusicladium diospyri spec. nov.

Maculae circulares, usque ad 10 mm. fusce olivaceo-brunneae, amphigenae, fructificatione diffusa; conidiophori compacte fasciculati, subcuticulares, pallide olivacei, haud ramosi, 10–18 x 5–7 μ. clavati vel cylindrici, sparse septati; conidia pallide olivacea tandem semel septata 18–28 x 7–10 magnit., insidentia singula apicibus conidiophororum.

In foliis viventibus *Diospyri* kaki, Saharanpur (U.P.) mense junio 1955 (M. L. Seth).

No *Fusicladium* sp. has so far been recorded on the genus *Diospyros* or on any other member of the family *Ebenaceae*.

72. *Phyllosticta sterculicola* Traverso, in Syd., *Ann. Mycol.*, **1** : n. 3, 1903; Saccardo in *Syll. Fung.* **18** : 222, 1906.

On living leaves of *Guazuma tomentosa* Kunth, Darjeeling (West Bengal) March, 1955, (Girdhari Lal).

Spots large, formed mostly along the margins of the leaves; *Pycnidia* scattered, epiphyllous, black, almost spherical, upto 200 μ in diameter; *Pycnospores* oval to elliptic, hyaline, unicellular, measuring 5–8 x 2–3 μ.

There is no record of any *Phyllosticta* sp. on *Guazuma*. The fungus

agrees in all respect with *P. sterculicola* which occurs on *Sterculia frondosa*, a member of the same family, *Sterculiaceae*..

73. *Colletogloeum dalbergiae* (Ahmad) Petrak, in *Sydowia*. **7** : 367, 1953; as *Septogloeum dalbergiae* Ahmad, in *Sydowia*. **7** : 269, 1953.

On living leaves of *Dalbergia sissoo* Roxb., I.A.R.I., Delhi, 23–12–1955 (Girdhari Lal).

Acervuli innate-erumpent, round, scattered, sometimes a few confluent and measuring upto 1.5 mm. in diameter; *Conidiophores* unbranched, septate, hyaline, measuring upto 30 x 3μ; *Conidia* somewhat cylindric, straight or curved, hyaline, 1–3 septate, measuring 15–35 x 2–3 μ.

74. *Pestalotia cryptomeriae* Cooke, in *Grev*. **12** : 24, 1883; Saccardo in *Syll. Fung*. **3** : 792, 1884.

On drying leaf needles of *Cryptomeria japonica* (L. f.) D. Don; Manali (Kulu Valley), May, 1955 (L. M. Joshi).

Acervuli borne on the tips of the leaf needles which become necrotic, sparse and scattered; *Conidia* lanceolate with a prominent stalk, 3 celled, dark brown with hyaline apex, measuring 10–15 x 3–5 μ, triciliate.

75. *Isaria palmae* Stevens and King in *Ill. Biol. Mon.* **11**(2) : 59, 1927.

On the dry inflorescence of *Cocos nucifera* L., Tudilur, Coimbatore (Madras), 9–12–1951 (R. L. Munjal).

Coremia erect, numerous, each composed of closely united, parallel hyphae; cylindrical, sometimes tapering apically, measuring 1 mm. long and 40–100 μ wide, white. Hyphae composing Coremium non septate, simple, hyaline, 1.5–2 μ thick; *Spores* borne singly on hyphae on sides and and apex of coremium, suboval, hyaline, 3–5 x 4–6 μ.

We wish to record our grateful thanks to Dr. R. S. Vasudeva, Head of the Division of Mycology and Plant Pathology for his keen interest, helpful criticism and encouragement as also for providing necessary facilities for work. Our sincere thanks are also due to Rev. Father Dr. H. Santapau, Chief Botanist, Botanical Survey of India, for rendering the latin diagnosis of the new species.

Division of Mycology and Plant Pathology,
Indian Agricultural Research Institute,
New Delhi.

Explanation of Plates

Fig. 1. *Karschia prinsepiae*

T. S. through Apothecium showing Asci and Ascospores (Diagramatic).

Fig. 2. *Cryptomyces quercus*

(a) T. S. through leaf showing Apothecium (Diagrammatic).

(b) Ascus with ascospores.

Fig. 3. *Mycaureola indica*

Photomicrograph of perithecium showing Asci & Ascospores.

Fig. 4. *Septoria sarcococcae*

(a) T.S. through leaf showing pycnidium (Diagrammatic).

(b) Spore

Fig. 5. *Fusicladium diospyri*

T. S. through leaf showing stroma, conidiophores and conidia

PLATES

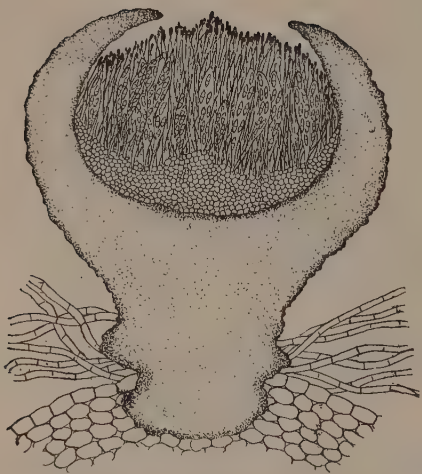


Fig. 1

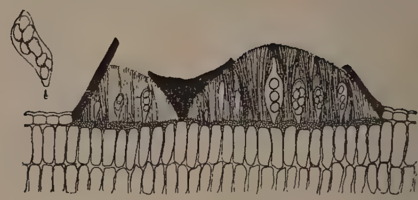


Fig. 2

Fig. 3

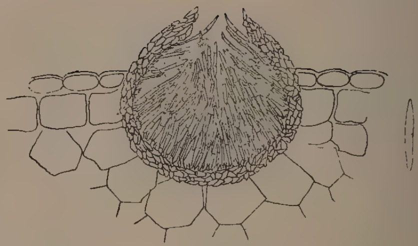


Fig. 4

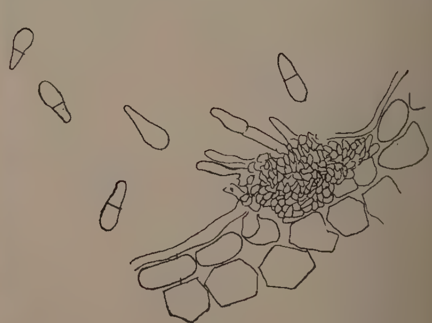


Fig. 5

NEW AND COMPLETE LIFE HISTORY OF PUCCINIA RUFIPES DIET.

By

N. V. Sundaram

(Accepted for publication May 26, 1956)

Dietel (1902) described the rust on *Imperata arundinacea* var. *koenigii* Dur. & Schw. from Japan as *Puccinia rufipes*. The same rust has been recorded from many other countries (Sydow 1910; Doidge 1950). In India this rust has been recorded from different parts by Butler and Bisby (1931). The uredial and telial stages alone were observed by these workers and the alternate host for this rust remained unknown.

During the month of September 1954 while the author was conducting field observations of certain diseases in the Agricultural Research Station, Ambalavayal (Wynaad), it was observed that by the side of heavily rusted plants of *I. arundinacea* var. *koenigii* the leaves of *Thunbergia alata* Boj. (Acanthaceae) were found bearing pycnia and aecia. This led to the suspicion that there may be some connection between the rusts on the two hosts. Inoculation tests were carried out under controlled conditions at Coimbatore and it was proved that *T. alata* acted as the alternate host for this rust. From the available literature there is no record of any aecidium on *T. alata*. The results of the experiment are briefly described in the following paragraphs.

Materials and Methods:

Seeds of *T.alata* were surface-sterilised by treating with Agrosan GN and were sown in pots containing sterilised soil. They germinated readily in the course of a fortnight. The inoculations were conducted on the first and second pairs of leaves. *I. arundinacea* var. *koenigii* was vegetatively propagated from cuttings. As there was no rust incidence in any of the plants they were used in the experiments. After inoculation the plants were covered with alkathene sheets or bell jars for 72 hours in the case of *I. arundinacea* var *koenigii* and for 7 days in the case of *T. alata*. The control plants used in the experiment were healthy throughout the period under experiment. Usual precautions were taken while conducting the inoculations.

Experimental results:

Uredia: The rust is prevalent in its uredial stage throughout the year both at Coimbatore and at Wynaad but is however very conspicuous during the months August to February. The rust spots are amphigenous and uredia are produced in the middle of them and are minute, linear, scattered or often coalescent forming long stripes upto 2 mm. long. They

are ochraceous brown in colour. Lighter coloured, capitate paraphyses are found mixed with the urediospores. Urediospores are subglobose or often ellipsoid or obovoid, dark brown, wall coloured, and echinulate. There are four equatorial germ pores. The spores measure 31 x 22 μ (19–37 x 16–25).

The urediospores germinated readily in tap water in six hours producing long and stout germ tubes with light brown contents. Viable urediospores were used to inoculate the healthy leaves of *I. arundinacea* var. *koenigii* specially raised for this purpose. Discoloured spots were visible on the inoculated leaves after the lapse of eight days. The rust sori, however, were formed only after 15 days from the date of inoculation. The epidermis burst open in two days after the formation of the uredia exposing the brown urediospores.

Telia: The telia are more commonly formed after August and continued till January. They are amphigenous, scattered or crowded together, paraphysate and mixed with the uredia. The teliospores are ellipsoid, rounded at both ends, slightly constricted at the septum, chestnut brown, measuring 31 x 22 μ (25–36 x 19–25), with smooth surface. The apex of the spore is thickened up to 7.5 μ. The pedicel is persistent, reddish brown, up to 75 μ long, sometimes obliquely attached. The teliospores germinated without a rest period by producing four celled, hyaline basidia. The basidiospores are oval to round, hyaline and are produced on short, pointed sterigmata.

Pycnia and aecia on Thunbergia alata:

The germinating teliospores were used for inoculating the healthy leaves of *T. alata*. The plants were sprayed and then covered with bell jar or alkathene tube for one week. On the seventh day yellowish discolouration on the upper surface was visible. In the course of three days pycnia were visible on both the surfaces of the spots with creamy white excretions of the nectar. Further development of the pycnia were however confined to the lower surface only. By this time the affected portions of the leaves were thickened and bulged and were convex on the upper surface. On the fourteenth day, the formation of the aecia could be noticed as dome shaped projections surrounding the pycnia. The aecia burst open in 2–3 days exposing the yellowish aeciospores with a margin of lacerated whitish peridial wall.

In one of the series of experiments aecia did not develop on leaves which were bearing isolated groups of pycnia. The nectar from one group of pycnia was carefully removed with the help of a sterilised brush and was mixed with that of the other and then the plants were kept covered. The aecia formed after six days, thereby suggesting the heterothallic nature of the rust.

Pycnia: They are oval to subglobose, light orange coloured, sub epidermal, 93 to 140 μ broad and 108 to 162 μ high. Ostiolar bristles are seen in clusters protruding through the ostiole. Drops of nectar, creamy white in colour, collect at the mouth of the ostiole. The

pycniospores are minute and are elliptical to oval in shape. When the pycnia become older the colour changes to cinnamon brown.

Aecia: Aecia are hypophyllous, cupulate, clustered, orange in colour, subepidermal, peridiate. The margin of the peridium is lacerated and recurved, and measures 340 to 548 μ high and 280 to 520 μ broad. The peridial cells are polygonal, hyaline, the free surfaces being strongly verrucose, measuring 26–38 x 16–26 μ. Aeciospores are catenulate, subglobose, thin walled, and with finely verruculose surface. They measure 25 x 19 μ (19–28 x 16–25). The contents of the spores are yellowish orange in colour.

Inoculation with the aeciospores:

The fresh aeciospores germinated readily in tap water by producing thin long germ tube with hyaline contents. In order to complete the life cycle, inoculations were done with viable aeciospores on the healthy leaves of *I. arundinacea* var. *koenigii*. Typical uredia were produced in the course of 15–16 days on the inoculated leaves. The control plants remained healthy.

Identity of the fungus:

Six rusts viz., *Puccinia rufipes, P. imperatae* (Magn.) Poir., *P. microspora* Diet., *P. miscanthi* Miura, *P. fragosoana* Beltran and *P. posadensis* Sacc. and Trott. have been recorded on this host genus (Cummins 1953). The general characters and the spore measurements of the rust under study are in close agreement with that of *P. rufipes* and hence the rust is identified as such.

Emended description of the rust:

Since the alternate host of the rust has been discovered it has become necessary to provide an emended description of the rust including all the states of its development and it is given hereunder;

Pycnia and aecia on *Thunbergia alata;* uredia and telia on *Imperata arundinacea* var. *koenigii.*

Pycnia and aecia: Rust spots yellowish, hypertrophied, amphigenous, round; pycnia mostly hypophyllous, light orange coloured, sub-epidermal, with ostiolar bristles, 93 to 140 μ broad and 108 to 162 μ high; pycniospore elliptic to oval, subhyaline; aecia hypophyllous, cupulate, clustered, orange coloured with recurved, lacerated peridium, 340–548 μ high and 280 to 520 μ broad; peridial cells hyaline, polygonal, inner wall densely and strongly verrucose, 26–38 x 16–26 μ; aeciospores catenulate, subglobose, thin-walled, surface finely verruculose, contents orange yellow coloured, 25 x 19 μ (19–28 x 16–25 μ).

Uredia and telia: Rust spots amphigenous, on the leaf blade and leaf sheath; uredia amphigenous, mostly epiphyllous on the leaf blades, linear, scattered or often coalescent forming long stripes up to 2 mm. long, orchraceous brown, paraphysate, paraphyses capitate, brown, thick walled; urediospores subglobose, ellipsoid or obovoid, dark brown, wall coloured and echinulate, germpores four, equatorial, 31 x 22 μ (19–37 x

16–25 μ); telia amphigenous, mixed with the uredia, paraphysate, paraphyses as in uredia; teliospores ellipsoid, rounded at both ends, slightly constricted at the septum, chestnut brown, 32 x 22 μ (25–36 x 19–25), smooth, apex up to 7.5 μ thick, pedicel persistent, reddish brown, up to 75 μ long, sometimes obliquely attached.

Summary

The complete life history of the rust *P. rufipes* has been worked out. *Thunbergia alata*, a weed growing in Wynaad, was found to serve as the alternate host. The aecidia occur abundantly on the host in nature during the rainy periods.

Acknowledgment

I am thankful to Shri M. Kandaswamy, Government Mycologist, for his encouragement in the work. I am also thankful to Shri T. S. Ramakrishnan for critically going though the manuscript.

Reference:

Butler, E. J. & Bisby, G. R. (1931). Fungi of India: *Sci. Monogr.* I.C.A.R. Bull. No. 1

Cummins, G. B. (1953). The Species of *Puccinia* parasitic on the Andropogoneae *Uredineana*, IV, 5–90.

Dietel, P. (1902). *Engler's Bot. Jahrb.*, 32: 48

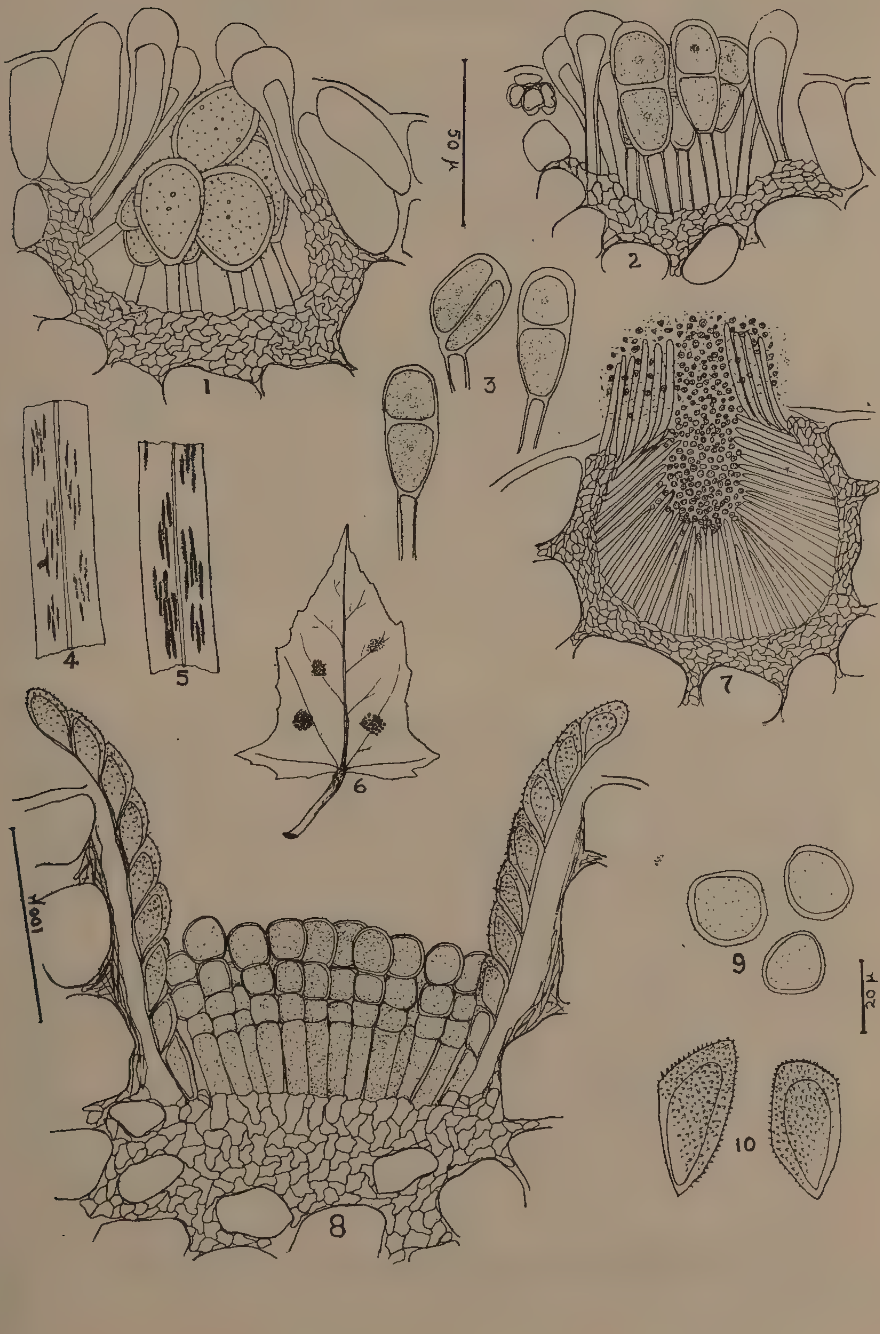
Doidge, E. M. (1950). *Bothalia*, 5 : 426.

Sydow, P. & H. (1904). *Monogr. Ured.*, 1: 757.

Explanation of Plate

(1) Section of uredium (2) Section of telium (3) Teliospores (4) A portion of leaf showing the uredia (diagrammatic) (5) A portion of leaf showing the telia (diagrammatic)) (6) Leaf of *T. alata* showing the aecia (diagrammatic) (7) Section of pycnium (8) Section of aecium (9) Aeciospores and (10) Peridial cells.

PLATES



SOME ADDITIONS TO INDIAN ASPERGILLI

S. B. Saksena and P. K. Shetye

(Accepted for publication June 8, 1956)

In a recent publication Mohanty (1948) who gave a monographic treatment to Indian Aspergilli recognized twentyfour valid species. To this list Chattopadhyay and Das Gupta (1953) added three more species thus raising the total to twentyseven.

The writers have been investigating the soil microfungi of the forest soils of Sagar for the last few years and have encountered 18 species of *Aspergillus* (including strains), out of which three species viz., (i) *Aspergillus ruber*, (ii) *Aspergillus niveus* and (iii) *Aspergillus sclerotiorum* (2 strains) have been recorded for the first time from India. The description of these four members is given in this paper. For the purpose of identification the monograph by Thom and Raper (1946) has been followed. The fungi were grown on Czapek's agar medium as suggested by them.

The cultures of these species are being deposited in the Indian type culture collection of fungi, Indian Agric. Res. Inst., New Delhi, India. The inclusion of these three species raises the number of valid recognizable species of *Aspergillus* to thirty in India.

Description of the Species

Aspergillus ruber (Brem.) Thom & Raper syn. *Eurotium rubrum* Bremer *Aspergillus sejunctus* Bain. & Sart.

Colonies on Czapek's agar (with 3% sucrose) growing at moderate rate at 28°C., plane, orange brown in colour, changing to Morocco red (Colour Pl. 6K, 11)* when old; reverse yellow (Col. Pl. 11K, 3) at first finally becoming dark brown. Perithecia abundant borne on a dense layer at the agar surface and largely covered within and beneath a close textured felt of orange red encrusted hyphae. Conidial heads come out of the hyphal felt, greyish at first becoming olivaceous green at maturity and old age, scattered unevenly over the colony but abundant at the margins. Heads loosely radiate, 300 to 425 μ in diameter. Conidiophores mostly septate, smooth, colourless, flexuous, 425 to 650 μ by 9.5 to 11.2 μ, diameter broadening to 12.8 to 14.4 μ near the vesicle. Vesicles subglobose, 17.5 to 25.5 μ in diameter; sterigmata in single series, 8.4 to 14.0 μ by 3.5 to 4.9 μ. Conidia elliptical to subglobose, spinulose, 6.3 to 8.4 μ by 4.9 to 5.6 μ. Perithecia orange red enmeshed in a felt at the agar surface, subspherical, 70 to 105 μ; asci 14.0 to 15.4μ in diameter; ascospores lenticular, 5.6 to 6.4 μ by 4.2 to 4.9 μ in lateral axis, with a typical furrow as a broad and shallow depression, roughness concentrated only along the low equitorial ridges.

---

* The colour plates referred to are from Maerz & Paul's "Dictionary of Color"

The present strain conforms closely with the description of culture NRRL No. 76 given by Thom and Raper (1945) in having a close felt of red brown hyphae and the scarcity of conidial heads which are mostly confined to the margins of the colony.

The fungus was isolated from a soil sample from a lime bed at Sagar. The sample was collected from the depth of 6 - 12 inches with a pH of 8.4 and a moisture content 9.8%. The surface of the soil was exposed and eroded with a very little vegetation which consisted of a few weeds and grasses such as *Tridax procumbens* Linn., *Euphorbia thymifolia* Burm., *Bothriochloa pertusa* Willd., *Dichanthium annulatum* Stapf., *Iseilema anthephoroides* Hack.

Aspergillus niveus Blochwitz

syn. *A. eburneus* Biourge.

Colonies on Czapek's agar growing slowly at 25°C., attaining a diameter of 2–2.5 cm. in 8 to 10 days consisting of a dense felt of mycelium, initially white, later becoming slightly pinkish (Colour Pl. 11A, 3); reverse yellowish brown (Col. Pl. 13H, 5), at first plane, later becoming radially furrowed; conidial heads white to pinkish, loosely columnar, upto 150 μ long by 25–40 μ in diameter, conidiophores smooth walled (wall 0.5 to 0.7μ thick), colourless, sinuate, occasionally septate, upto 500 μ long by 3.5 to 4.9 μ. Vesicles hemispherical, 5.6 to 8μ in diameter, fertile usually upto upper one-third to one-half portion. Sterigmata in two series, primary 4.2 to 6.0 μ by 2.0 to 2.5 μ; secondary 5.0 to 7.5μ by 1.4 to 2.1 μ. Conidia globose , 2.1 to 2.8μ in diameter, smooth, thin-walled, colourless.

In morphological details the fungus closely agrees with the description given by Thom and Raper (1945). The original Blochwitz's description does not mention about the presence of yellow colour which has been recorded here and also in Thom and Raper's description. The species is apt to be mistaken with *Aspergillus candidus* by its white heads with smooth colourless conidiophores and smooth conidia. It can, however, be distinguished by loosely columnar character of heads and a vesicle which is not fertile completely all over its surface and the absence of sclerotia. Inspite of this, the affinities between the two groups are quite well marked.

Ecologically, the fungus was collected from two different soil types, one from a forest soil which was dark brown and loamy with pH of 7.5. The fungus was recorded upto the depth of 12 inches. The ground tree vegetation consisted mainly of *Butea monosperma* O. Ktze, *Diospyros melanoxylon* Roxb., and *Anona squamosa* Linn. Second time it was collected from a grassland soil which was black, clayey loam with a pH of 7.5. The main grasses in the area were *Dichanthium annulatum* Stapf., *Bothriochloa pertusa* Willd. and *Iseilema anthephoroides* Hack.

Aspergillus sclerotiorum Huber (Strain 1)

Colonies on Czapek's agar growing at a moderate rate attaining a diameter of about 3.0 to 4.0 cm. in 8 days at about 28°C., forming a smooth

mycelial layer with irregular development of aerial sterile hyphae within which sclerotia develop profusely and dominate the colony very soon, yellowish or ochraceous in colour (Colour Pl. 12H, 8) reverse of the same tinge but darker (Colour Pl. 14L, 12). Conidial heads not very abundant, whitish to creamish buff in colour, more or less radiate, of varying size, 80 to 110 μ in diameter; conidiophores with walls yellow, wavy with slight roughening and occasional small tubercles, commonly from 350 to 600 μ by 5.0 to 6.5 μ. Vesicles globose, 16 to 20 μ in diameter, sterigmata in two series closely packed, primary 10.5 to 11.2μ by 2.8 to 3.5μ, secondary 6.0 to 9.1 μ by 2.5μ. Conidia globose to slightly oval, smooth, yellowish in mass, 2.0 to 2.5 μ in diameter. Sclerotia abundant, beginning to appear within 3 - 5 days of inoculation, white to creamish, round to oval in shape, big, upto 0.5 to 0.7 mm. in diameter, scattered all over the surface excepting the margin, giving the characteristic appearance to the colony.

The fungus agrees, both in morphology and measurements, closely with the type description excepting that the heads tend to be radiate rather than columnar. Moreover, the size of the sclerotia is also smaller which usually have a diameter of 0.5 mm.*

This fungus has not been reported from soil so far. The description given by Thom and Raper (1945), with which the above description tallies closely, is based on Huber's (1933) isolate which was found on rotting apples and pears. The fungus was collected only once during the present studies and was isolated from a forest grassland soil mentioned above in case of *A. niveus.*

Aspergillus sclerotiorum Huber (Strain 2)

Colonies on Czapek's agar spreading broadly at a moderate rate forming a smooth mycelial layer with loose tufts of sterile hyphae within which sclerotia develop abundantly in concentric zones dominating the colony colour, which changes from white to pinkish ochre (Colour Pl. 11E,8) on maturation; reverse at first pale yellow, later becoming tan particularly notable below the sclerotia. Conidial heads straw coloured (Col. Pl. 102F, 6) usually occurring at the colony margins, occasionally between the sclerotial zones, columnar with masses of conidia splitting into 2 to 3 divergent columns, 196 to 225 μ by 72 to 105 μ. Conidiophores yellow with pitted walls, sometimes impregnated with tubercles, 352 to 512 μ by 4.9 to 7.0 μ. Vesicles subglobose, 17.5 to 20.0 μ in diameter; sterigmata in two series, primary 7.0 to 9.8 μ by 3.5 to 4.2 μ, secondary 7.5 to 8.5 μ by 2.1 to 3.5 μ. Conidia globose pale yellow in mass, smooth, 2.8 to 3.5 μ in diameter. Sclerotia abundant, very big upto 2 mm. in diameter, produced in concentric zones dominating the colony appearance.

The fungus agrees in morphological details with the description given by Thom and Raper (1945) excepting that the size of the sclerotia is very big in this case.

* One more strain closely resembling the above but having bigger sclerotia (upto 1 mm.) was also isolated but unfortunately lost in culture.

The fungus was collected from the soil sample of a lime bed of Sagar. It was found to inhabit the upper layers (0 to 6 inches) of the soil. The ecological conditions were the same as recorded in the case of *A. ruber*.

Summary

Three species of *Aspergillus* namely *A. ruber* (Brem). Thom and Raper, *A. niveus* Blochwitz and *A. sclerotiorum* Huber (Two strains) which were collected for the first time from India have been described in detail. These were collected from forest and grass-land soils of Sagar. With their inclusion the total number of recognisable valid Indian species of *Aspergillus* is now thirty.

Acknowledgments

The writers wish to express their gratitude to Dr. R. K. Saksena of the Allahabad University for his valuable guidance.

Dept. of Botany,
University of Saugar,
Sagar.

References

Chattopadhyay, S. B. and Das Gupta, C. (1953). Contribution to knowledge of Indian Aspergilli. *Indian Phytopathology*. **6**: 92 - 95.

Mohanty, U. (1948). Studies on Indian Aspergilli. *Indian Phytopathology*. **1** : 55 - 65.

Saksena, S. B. (1955). Ecological factors governing the distribution of soil microfungi in some forest soils of Sagar. *J. Indian Bot. Soc.*, **34** : 262 - 298.

Thom, C. and Raper, K. B. (1945). A Manual of the Aspergilli. The Williams & Wilkins Company, Baltimore, Md., pp. 373.

Explanation of Plates

1. (a - b) *Aspergillus sclerotiorum* (Strain 1)
   - (a) 10-days old colonies showing sclerotia, ½ natural size.
   - (b) Sclerotia
   - (c) Vesicle with tuberculate conidiophore
2. (a & b) *Aspergillus sclerotiorum* (Strain 2)
   - (a) Colonies showing sclerotia, ½ natural size.
   - (b) Sclerotia
3. (a - c) *Aspergillus ruber*
   - (a) Conidiophore with single sterigmata, vesicle and echinulate conidia

(b) Perithecium with asci

(c) Ascospores lateral as well as in surface views

4. *Aspergillus niveus*

Part of conidiophore with double sterigmata, vesicle and conidia

EXPLANATION OF TEXT-FIGURES (1 - 4)

Fig. 1. *Aspergillus sclerotiorum* (Strain 1)

(a) Conidial head with a tuberculate conidiophore

(b) Conidia

Fig. 2. *Aspergillus niveus*

(a) Conidial head with a smooth conidiophore, vesicle half covered with sterigmata

(b) Conidia

Fig. 3. *Aspergillus ruber*

(a) Showing vesicle with single sterigmata, septate conidiophore

(b) Conidia

(c) Perithecium with asci lodged with ascospores

(d) Pulley shaped ascospores in lateral and surface views

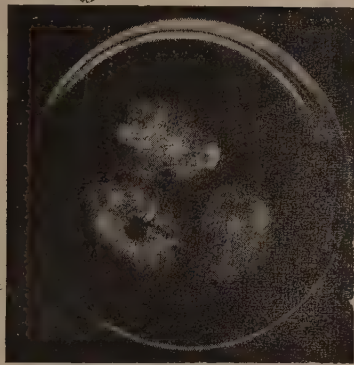
Fig. 4. *Aspergillus sclerotiorum* (Strain 2)

(a) Conidial head with tuberculate conidiophore

(b) Conidia

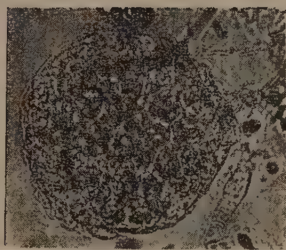
PLATES

1a

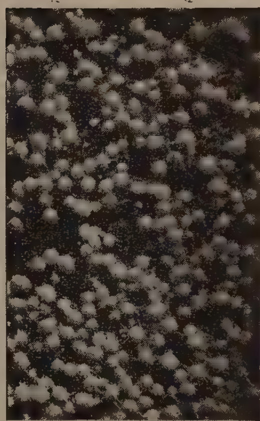


2a

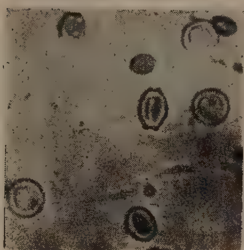
1b



3b



2b



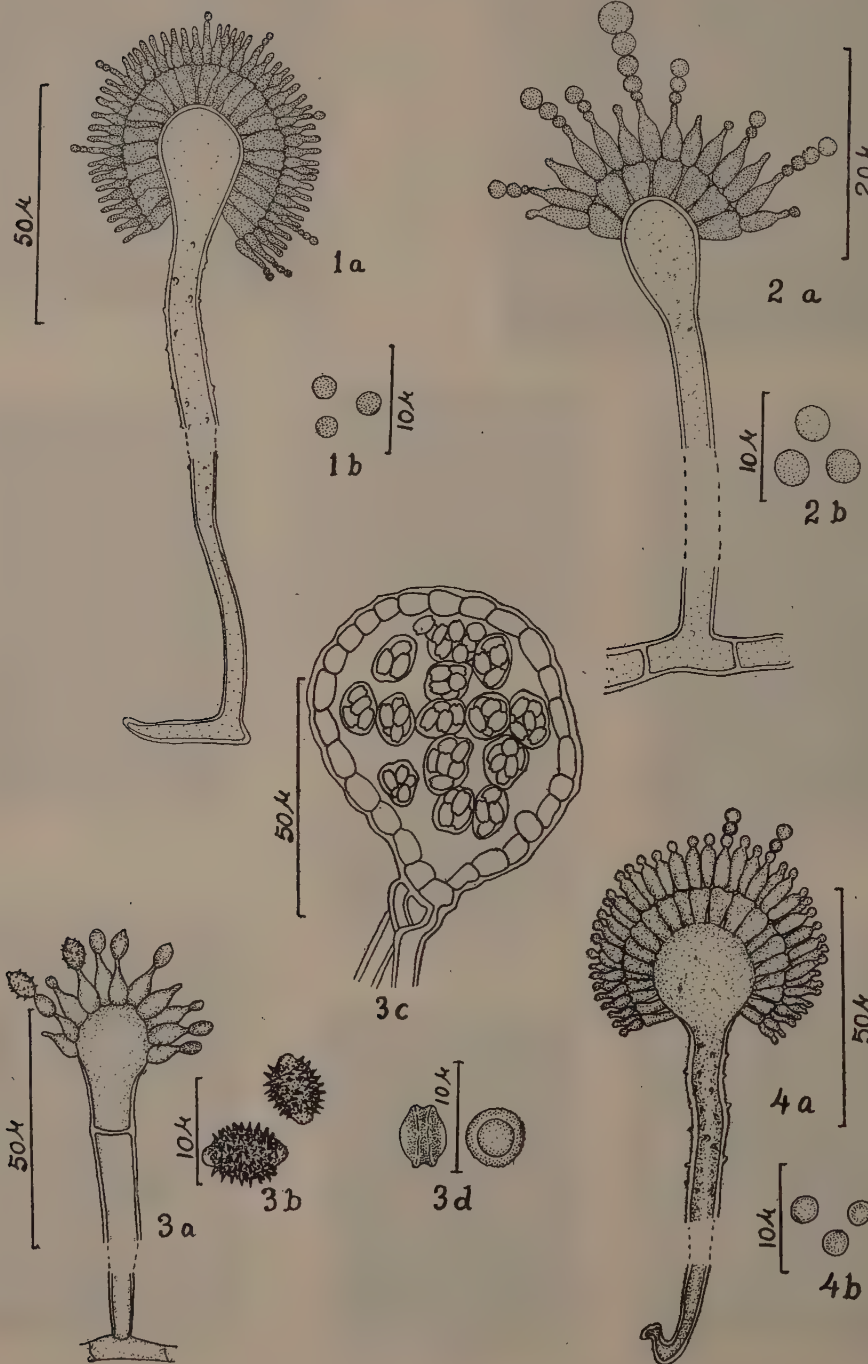
3c

3a

4a

1c

TEXT FIGURES (1-4)



SEEDLING BLIGHT OF TOBACCO

CAUSED BY PHYTOPHTHORA PARASITICA, var. NICOTIANAE. (Van Breda de Haan) Tucker

P. Govindarao & D. Koteswararao.

(Accepted for publication May 9, 1956)

Virginia tobacco is an important commercial crop in the Andhra State and is grown in about 3,46,000 acres out of which 2,07,000 acres are distributed in Guntur District alone. The crop is cultivated in the black soils of the inland while the seedlings are raised every year in about 2,000 acres of sandy stretches of the sea coast. These seedlings are supplied not only to Guntur but also to Krishna, Godavari, and Nellore Districts.

In recent years the nursery growers sustained a severe loss due to a blight disease of tobacco seedlings. During the rainy season the disease is evident first on the lower leaves of 2-month old tobacco seedlings as large, grey, irregularly round, papery spots (Plate 1). Following a shower of rain the infection begins as dark specks on the leaves which widen rapidly by centrifugal growth thus becoming round spots. But midrib checks the growth of the spot and consequently it spreads along the midrib becoming an elongated, irregular spot. Two or three spots may develop on a single leaf and coalesce freely involving a major portion of the leaf blade. The disease advances rapidly to the petiole and stem causing black discoloration in the first instance. Eventually wet rot results in the affected tissues of leaf, petiole and stem due to the loss of turgidity of the cells. The seedlings succumb to infection and rot by falling on the ground. In moist and warm weather the disease spreads rapidly and patches of dead seedlings are found among the healthy green seedlings. In 1953 during the week preceding the outbreak of the epiphytotic the humidity was above 90% on all days and the temperature varied from 74° F to 89°F. Fresh infection usually preceeds a shower of rain. In certain conditions which are probably not favourable for the pathogen, the disease develops slowly and restricts itself to leaf lesions, which become brown, papery, dry and sometimes perforated in the centre.

Sporangia of *Phytophthora* are always found to be associated with the leaf spots. The affected tissues are full of non-septate, branched mycelium with full of granular protoplasm. The hyphae usually measure 3.1 μ thick but rarely they are upto 4.7 μ thick. The sporangia are borne terminally on long, slender and unbranched sporangiophores arising on both surfaces of the spot. The sporangiophores emerge from inside the leaf either singly or rarely in groups of two or three. They measure on average 39–233 μ x 2.3 –3.1 μ. The sporangia are colourless, thin walled, smooth and generally elliptical or pear shaped. Some are either much elongated or round. At the free end there is always a broad, blunt papilla. The sporangia measure 40 x 25 μ (28–59 x 19–31 μ). Oospores are not found in nature.

The fungus *Phytophthora* has been reported from India (Galloway 1936, Anonymous 1936) to be the cause of rotting of tobacco seedlings. But a detailed description of the disease and the range of pathogenicity of the fungus are not yet available.

Pathogenicity trials.

1. *On tobacco:* A species of *Phytophthora* was isolated from the tissues of tobacco leaf spots. This culture was used as inoculum to determine its pathogenecity on different parts of tobacco plant viz., leaves, stem and roots. The plants were kept in a glass cage after inoculation. The isolate was found to be virulently pathogenic on all parts of the tobacco plant.

Infection was evident by the development of grey, water-soaked spots within four days in wounded leaves and within eight days in unwounded leaves of about 3 month old tobacco plants. Gradually, the whole leaf dried and the infection advanced to the stem causing black streaks on it. Eventually the inoculated plants died while the control plants were healthy. Black streaks developed within a week after inoculation on the wounded stems of four month old tobacco plants. The blackening gradually extended and the plants died. When the roots of about 5 month old tobacco plants were inoculated infection was evident as black streaks at the base of the stem 17 days after inoculation. As the blackening advanced up the stem the basal leaves drooped becoming yellow and later brown. Eventually the plants wilted and the brown leaves were seen hanging from the woody stem, resembling the typical "Black shank" symptoms (Plate II). Thus it is evident that the same organism causes seedling blight in the nursery and 'Black shank' disease in the adult plants. The controls remained healthy in each type of inoculation.

2. *On other plants:* With a view to determine the host range, inoculations were carried out with the present isolate of *Phytophthora* on healthy tomato, castor, brinjal, jatropha, colocasia and opuntia plants and on the detached fruits of brinjal, coconut and chillies and on colocasia rhizomes. The following results were obtained.

Suitable controls were maintained in all the cases and these remained healthy throughout the period of observation. Infection was confined to leaves as grey, indefinite, water soaked spots in *Lycopersicum esculentum*, and *Solanum melongena*. But in *Ricinus communis* leaf lesions developed only on wounded leaves. On unwounded leaves the infection occurred only as small grey spots on one of the cotyledonary leaves. Young seedlings of *L. esculentum* were completely blighted by the isolate. The fruits of *Solanum melongena* rotted due to infection. The virulence of the isolate varied from host to host. The isolate did not infect *Jatropha sp.*, *Colocasia antiquorum*, *Opuntia sp.*, fruits of *Cocos nucifera* and *Capsicum annuum*.

Cultural Characters of the isolate.

The fungus grew well on oats agar medium producing plenty of cottony, aerial mycelium. Oospores were formed in plenty. The wall of the

oospore was brown and its contents light brown. The oogonial wall was hyaline. The mature oospore filled the oogonium completely. The oospores were regularly spherical measuring 24.5 μ (19 - 28 μ) in diameter. The antheridium was seen attached to the mature oospore surrounding the oogonial stalk. Thus the antheridium was found to be of amphigynous type. Limited number of sporangia were formed. But when a small portion of the mycelial mat was incubated in a moist chamber plenty of sporangia were formed. The sporangium produced zoospores which were liberated from the apex. It was also found to germinate directly producing a germ tube from the papillar end. (See fig. 1).

Identity of the isolate:

Different views were expressed about the specific name of the *Phytophthora* infecting tobacco. The salient features of these views were

Results of inoculation and other hosts.

No.	Host plant	Part inoculated.	Number inoculated	Number infected	Interval in days.	REMARKS
1.	*Lycopersicum esculentum*	Young seedlings	38	26	4	
		Leaves unwounded	26	26	4*	
2.	*Ricinus communis*	Leaves wounded	14	7	4*	
		Leaves unwounded	4	1*	5	Small spots developed only on cotylendonary leaf.
3.	*Solanum melongena*	Leaves unwounded	27	13	3*	
		Fruits wounded	4	4	4	
4.	*Jatropha sp.*	Leaves wounded	24	Nil	—	
5.	*Colocasia antiquorum.*	Leaves wounded	13	Nil	—	
6.	*Opuntia sp.*	Stem wounded	8	Nil	—	
7.	*Cocos nucifera*	Small green fruits wounded.	12	Nil	—	
8.	*Capsicum annuum*	Green fruits wounded.	5	Nil	—	

* Since the pathogenicity was established on even unwounded parts of wounded plants, inoculation was not tried. Wounded inoculation was adopted in cases where unwounded inoculation gave negative results or the infection was not clearly established.

summarised by Wolf (1935) as follows. Van Breda de Haan in 1896 first described the black shank fungus as *Phytophthora nicotianae*; Dastur (1913) described a *Phytophthora* from castor which was morphologically similar to *P. nicotianae.* But because it is not pathogenic on tobacco he regarded the organism as distinct from *P. nicotianae* and named it as *P. parasitica.* But Palm in 1924 recorded the presence of *P. nicotianae* on castor, tomato and two weeds (*Commelina nudiflora* and *Trema ambionesnis*). Tisdale and Kelly in 1926 successfully inoculated tomato, potato, brinjal and castor with *Phytophthora nicotianae.* These workers found that castor was equally susceptible to infection by *P. parasitica* or *P. nicotianae.* Further they found that *P. parasitica* was capable of producing black shank when inoculated into tobacco although not so virulently as *P. nicotianae.* In 1925, Leonian, after a cultural study of the various species of *Phytophthora,* noted that *P. nicotianae* closely resembled *P. parasitica.* Asbhy in 1928 after making a comparative cultural study of various species of *Phytophthora* proposed that *P. nicotianae* be merged with *P. parasitica* with two sections based on the size of the oospores. Tucker regarded tobacco black shank fungus as *P. parasitica* var. *nicotianae* due to its virulent pathogenicity on tobacco.

Thomas et al (1947) isolated a species of *Phytophthora* from tobacco stem and found it to be heterothallic. They merged it with *P. palmivora* Butl. since it is morphologically similar and does not exhibit any constant difference from *P. palmivora.* The specific affinity between their isolate and *P. palmivora* was further demonstrated by the formation of oospores by their isolate when paired with opposite strains belonging to *P. palmivora* group. The same authors in 1948 proposed merging of *P. palmivora, Phytophthora parasitica* its varieties and *P. colocasiae* into one species since there were no significant interspecific differences and the name *P. colocasiae* was suggested for the new species.

The present isolate, even though pathogenic on castor, is not so virulent as the castor *Phytophthora.* When the isolate of castor *Phtophthora* was inoculated on its own host without wounding, it caused complete death of the 25 day-old seedlings whereas the present isolate caused only leaf spots even with wound inoculation. Thus the two isolates are not identical. Further, size and shape of sporangia and oospores, amphigynous nature of the antheridium, non-production of oospores in nature and their production in culture media indicate that the present isolate is *Phytophtora parasitica* var. *nicotianae* (Van Breda de Haan) Tucker.

Summary

A species of *Phytophthora* was isolated from the leaves of Virginia tobacco seedlings. The isolate was found to cause spots on leaves with the infection gradually spreading through the petiole into the stem causing the blackening of the stem and petiole and consequently collapse of the seedlings. When inoculated on 5 months old virginia tobacco plants typical black shank symptoms were observed. From a study of the morphological characters and the pathogenicity tests it was observed that the present isolate was

identical with *P. parasitica* var. *nicotianae*. Hence it was accordingly named.

Mycology Section,

Agricultural College, Bapatla.

References

DASTUR J. F. (1913). On *Phytophthora parasitica* nov. sp. A New disease of the castor oil plant. *Mem. Dept. Agri. in India–Botanical Series* **5** : 177–251.

GALLOWAY, L. D. (1936). Report of the Imperial Mycologist *Sci. Rep. Agri. Res. Inst. Pusa*. 1934-35 P. 120-130 (Abstract in R.A.M. XVI, 1937. P. 231).

GOVINDARAO, P. AND KOTESWARARAO, D. Occurrence of *Phytophthora parasitica Var. nicotianae* on tobacco in Bapatla (Andhra) *Sci.* and *Cult.*, **21** : 39.

THOMAS K. M. ET AL (1947). Studies in the Genus *Phytophthora* I *Proc. Indian Acad. Sci. B.* **26** : 147-163.

————(1948). Studies in the Genus *Phytophthora* II *Proc. Indian Acad. Sci.* **27** : 55–73.

WOLF, F. A. (1935). Tobacco Diseases and Decays. Duke University Press Durham, North Carolina.

ANONYMOUS (1936). Annual Report of the Mycology Section for the year ending 31st. March 1936, *Rep. Dept. Agric. Cent. Prov. Berar;* pp. 26–29 (Abstract R.A.M. Vol. XVI, 1937 p. 233.)

Explanation of Plates.

1. Tobacco leaves infected by *phytophthora* from a two months old nursery.
2. Black shank disease produced on adult plants by inoculating with Phytophthora isolated from Tobacco leaves of nursery stage.

   (1) Healthy (2) Diseased.

———

PLATES

Plate 1

Plate 2

1-4. SPORANGIA.
5 SPORANGIUM JUST BEFOPE THE LIBERATION OF ZOOSPORES.
6. SPORANGIUM LIBERATING THE ZOOSPORES.
7 SPORANGIUM AFTER THE LIBERATION OF ZOOSPORES.
8-9. DIRECT GERMINATION OF THE SPORANGIUM.
10-11. OOSPORES WITH AMPHIGYNOUS ANTHERIDIA.

Fig. 1

LEAF CURL OF PAPAYA

T. K. Nariani

(Accepted for publication June, 1, 1956)

A leaf-curl disease of Papaya (*Carica papaya* L.) has been prevalent in Delhi for several years. Recently the disease has been on the increase and has caused considerable damage both to the commercial plantations as well as the kitchen garden trees.

Papaya 'leaf-curl' was first recorded by Thomas (1939) from Madras. Thomas and Krishnaswami (1939) described a similar disease called 'leaf-crinkle' from Coimbatore and reported its transmission by grafting. Sen *et al*. (1946) described a juice-transmissible leaf-curl of papaya from Bihar.

In the present paper a brief account of the disease, its insect transmission, and the identity of the causal virus have been reported.

Symptomatology

Leaf-curl of papaya is characterised by severe curling, crinkling and distortion of the leaves accompanied by vein clearing and reduction in leaf size. Leaf margins are rolled downward and inward in the form of inverted cups, and the veins get thickened and turn dark green in colour. Also the petioles are twisted in a zig-zag manner. The leaves become leathery and brittle and the interveinal areas are raised on the upper surface due to hypertrophy which produces rugosity of leaves (Fig. 1). The affected plants fail to flower or bear very few fruits, and in advanced stages of the disease defoliation takes place and the growth of the plant is arrested.

Material and Methods

All inoculations were made on young vigorously growing papaya plants raised from seed in the insect-proof glass house and grown in 4" pots. Juice inoculations were done with sap extracted from young leaves of diseased papaya plants and inoculated by the leaf-rubbing method using carborundum as an abrasive. Grafts were made by wedge-grafting diseased papaya scions to about 6-month old healthy papaya stocks. Grafted plants were covered with bell jars to maintain high humidity. Insect transmission tests were conducted with white flies, *Bemisia tabaci* Gen. White flies were collected from a healthy colony of insects raised on healthy tobacco plants in an insectary. The feeding of the insects on the test plants was done in micro-cages. The test plants were sprayed with Nicotine sulphate after the insects were removed.

Transmission of the Virus

All attempts to transmit the disease by juice-inoculation were unsuccessful, but the disease was readily transmitted by grafting in about

5 - 7 weeks (Fig. 2). The leaves on the axillary shoots arising below the grafted portion on the stock showed vein-clearing and slight curling of margins. This was followed by vein-thickening, severe puckering of the leaves, and bending and twisting of petioles.

Among the insects frequently found feeding on papaya, white fly was the most predominent. Transmission tests were, therefore, conducted with white flies only. The insects were fed in batches of 10-15 in micro-cages on diseased papaya leaves for 16 - 24 hours and then released on young healthy papaya plants for 24 - 48 hours. The disease was transmitted to 11 out of 16 plants inoculated by means of white flies and the leaf-curl symptoms appeared in 2 - 8 weeks. (Fig. 3).

Host Plants

Since White-fly transmitted leaf-curl viruses have been reported on tobacco (Pruthi and Samuel, 1937), cotton (Kirkpatrick, 1931), tomato (Vasudeva, and Samraj, 1948) and *Hibiscus rosa-sinensis* (Vasudeva *et al.*, 1953), attempts were made to transmit the papaya leaf-curl virus to these plant species by means of the white-fly. The results (Table 1) show that the papaya leaf-curl virus could not be transmitted to cotton, Bhindi or *Hibiscus rosa-sinensis*., but was readily transmitted to tobacco and tomato (Fig. 3). Typical symptoms of leaf-curl were produced on tobacco and tomato in 20 to 30 days. Later, vein-thickenings and enations also developed on the under sides of tobacco leaves indicating that the leaf-curl disease in papaya is caused by the tobacco leaf-curl virus.

Table I

Transmission of papaya leaf-curl virus by white flies

Plant species	Plants inoculated	Plants infected
Tobacco var. White Burley	16	7
Tomato	10	9
Sakel cotton	6	0
Cotton var. 4F.	5	0
Bhindi	4	0
Hibiscus rosa-sinensis	4	0

Transmission of Tobacco Leaf Curl Virus to Papaya Through White Flies

A tobacco plant affected by the typical leaf curl virus was selected as the source of virus for these tests. White flies in groups of 10 to 15 were fed on leaf curl affected tobacco for 24 hours and then transferred to healthy papaya test plants in micro cages and allowed to feed for 24 to 48 hours. Typical symptoms of leaf-curl disease appeared in 6 out of 10 plants in about 30 days. These results confirmed the previous observations that the leaf-curl disease in papaya is caused by the tobacco leaf-curl virus.

Varietal Resistance Tests

Young plants of papaya varieties Ranchi, Bombay, Honeydew and Washington were inoculated by feeding viruliferous white flies on them. All papaya varieties tested came down with typical leaf-curl symptoms within 60 days showing that none of these were resistant to the virus.

Discussion

A number of virus diseases affecting papaya have been reported from various countries (Jensen, 1949a) including India (Capoor and Varma, 1948), but diseases characterised by leaf curling or leaf crinkling symptoms as also those transmitted through the agency of insects are few. Information on the transmission of most of these diseases is lacking except that the leaf-curl diseases reported from Santo Domingo (Ciferri, 1930) and from Bihar (Sen *et al.*, 1946) were shown to be mechanically transmitted. The leaf crinkle of Coimbatore (Thomas and Krishnaswami, 1939) and the leaf-curl of Madras (Thomas, 1939) are probably caused by the same virus. These closely resemble in symptom picture the papaya leaf-curl reported herein.

Of the insect transmitted virus diseases the papaya bunchy top, which is transmitted by the leaf-hopper, *Empoasca papayae* Oman, in Puerto Rico (Adsuar, 1946 a; Sein & Adsuar, 1947), is the only virus which is not transmitted mechanically, while papaya ringspot of Hawaii (Jensen, 1949b), mosaic of Puerto Rico (Adsuar, 1946b) and mosaic virus in India (Capoor and Varma, 1948) have aphids as their vectors and all are juice-transmissible. Although the tobacco leaf-curl virus has been reported to be transmitted to papaya by means of white flies (1946, 1947) the symptoms produced on papaya have not been described, and as such the identity of the virus with that of naturally occurring papaya leaf curl could not be established. The present record is, therefore, the first report of a white fly transmitted virus naturally occurring on papaya. Presumably the leaf roll virus affecting papaya in Puerto Rico (Goenaga, 1945) is an unconfirmed record of the tobacco leaf-curl virus causing disease in papaya.

Because of the resemblance of symptoms and vector relationship between papaya leaf-curl and tobacco leaf-curl viruses, and the fact that the reciprocal transmission tests with infective white flies with both viruses and both hosts successfully established symptoms characteristic of the leaf-curl diseases in papaya as well as tobacco, it has been concluded that the leaf curl disease in papaya is caused by the tobacco leaf-curl virus.

I am very much indebted to Dr. R. S. Vasudeva, Head of the Division of Mycology and Plant Pathology for his keen interest and encouragement as also for helpful suggestions throughout the course of these investigations. My thanks are also due to Dr. S. P. Capoor, for going through the manuscript.

Summary

A leaf-curl disease of papaya (*Carica papaya* L.) characterised by

curling and crinkling of the leaves, and twisting and shortening of petioles has been described.

The disease was not transmitted mechanically but was readily transmitted by grafting and by means of the white fly, *Bemisia tabaci* Gen. Papaya varieties Ranchi, Bombay, Honey Dew and Washington were also readily infected by the virus. White-fly transmitted the virus to tobacco and tomato in which symptoms characteristic of leaf-curl virus were produced. Similarly, typical leaf-curl symptoms in papaya were produced, by tobacco leaf-curl virus in reciprocal inoculation tests by means of the infective white flies showing thereby that leaf curl in papaya is caused by the tobacco leaf-curl virus.

Division of Mycology and Plant Pathology,

Indian Agricultural Research Institute,

New Delhi.

References

Adsuar, J. (1946 a). Transmission of papaya bunchy top by a leaf hopper of the genus *Empoasca*. *Science*, **103** : 316.

————(1946 b). Studies on virus diseases of papaya (*Carica papaya* in Puerto Rico I. Transmission of papaya mosaic. *Univ, Peurto Rico Afr. Exp. Sta. Tech. Paper* No. 1.

Anonymous (1946, 47). Scientific reports of the I.A.R.I., 1945-46, 1946-47. Report of the Division of Entomology.

Capoor, S. P. and P. M. Varma. (1948). A mosaic disease of *Carica papaya* L. in the Bombay Province. *Curr. Sci.* **17** : 265-266.

Goenaga, A. (1945). Notes on diseases of tobacco observed in Puerto Rico during the 1944-45 season. *Plant Dis. Rept.* **29** : 311–314.

Jensen, D. D. (1949a). Papaya virus diseases with special reference to ringspot*ology* *Phytopathology*. **39** : 191-211.

———(1949b) Papaya ringspot virus and its insect vector relationships. *Phytopathology* **39** : 212-220.

Kirkpatrick, T. W. (1931). Further studies on leaf curl of cotton in the Sudan. *Bull. Entom. Res.* **22** : 323-363.

Pruthi, H. S. and C. K. Samuel. (1937). Entomological investigations on the leaf curl disease of tobacco in North Bihar, I. Transmission experiments with some suspected vectors. II. An alternate host of the virus and the insect transmitter. *Indian J. Agric. Sci.* **7** : 659-670.

SEIN, F, AND J. ADSUAR. (1947). Transmission of the bunchy top disease of papaya (*Carica papaya* L.) by the leaf hopper *Empoasca papayae* Oman. *Science*, **106** : 130.

SEN, P. K., B. D. GANGULI AND P. C. MALIK. (1946). A note on a leaf curl disease of papaya (*Carica papaya* L.). *Indian J. Hort.* **3** : 38-40.

THOMAS, K. M. (1939) New plant diseases recorded in India. *Intern. Bull. Plant. Prot. Year XIII* : 256 - 257.

THOMAS, K. M., AND C. S. KRISHNASWAMI! (1939). Leaf crinkle - a transmissible disease of papaya. *Curr. Sci.* **8** : 316.

VASUDEVA, R. S., AND J. SAMRAJ (1948). A leaf curl disease of tomato. *Phytopathology*, **38** : 364-369.

VASUDEVA, R. S., P. M. VARMA AND S. P. CAPOOR (1953). Some important white fly (*Bemisia tabaci* Gen.) transmitted viruses in India. *Proc. VI. Int. Microb. Confr.*, II : 605 - 606.

EXPLANATION OF FIGURES

Fig. 1. A papaya tree naturally infected with the leaf-curl virus.

Fig. 2. A papaya seedling infected by means of graft inoculation.

Fig. 3. White-fly transmission of the 'leaf-curl' virus to papaya, tomato and tobacco.

TEXT FIGURES

Leaf-Curl of Papaya

Fig. 1

TEXT FIGURES

Fig. 2

Fig. 3

THE MYXOMYCETES OF THE MUSSOORIE HILLS - V

K. S. Thind and H. S. Sohi

(Accepted for publication May 9, 1956)

This paper is intended to record more Myxomycetes from the Mussoorie Hills (5,000–7,000 ft. altitude in the North Western Himalayas) as a part of the study of the Fungal Flora of that region undertaken by the senior author and his students (Thind and Sohi, 1955. Thind and Sohi, 1956., Martin*, Thind and Sohi, 1956). Out of the seven species described here four species—*Cribraria dictydioides* Cooke & Balf., *Dictydium cancellatum* (Batsch) Macbr., *Diachea splendens* Peck, *Lamproderma Arcyrionema* Rost. are new records in India while *Cribraria languescens* Rex f. *magnigranosus* f. nov. is described here as a new form.

The classification of Martin, 1949, has been followed in the present study.

The numbers of the species are the serial numbers of the flora.

Type collections have been deposited in the Herbarium of the Panjab University. Duplicate material is in the State University of Iowa.

The authors are deeply indebted to Dr. G. W. Martin of the State University of Iowa, U.S.A. for help in the determination of the species and Prof. P. N. Mehra, Head of the Panjab University Botany Department, for providing facilities and encouragement. They wish to express their thanks to Mr. R. S. Pathania for taking microphotographs of the fruit bodies.

Order: *Liceales*

26. *Cribraria dictydioides* Cooke & Balf.

Fructifications sporangiate.

Sporangia gregarious, stipitate, deep brown, globose, 0.45–0.55 mm. in diameter: stipe very long, erect or bending, deep brown to dark brown, darker below, tapering upward, grooved throughout, up to 1.85 mm. long, i.e., about four times the diameter of the sporangium: calyculus small, represented by the ribs radiating from the top of the stipe, ribs numerous, thick, tapering upward, filled with foamy or reticulate brownish contents, ribs merge into the peridial net above: peridial net composed of a delicate and a small-meshed network of nodes and internodes: nodes thick, spherical to oblong, or elongated, brown, filled up with brownish, foamy or reticulate

* Three new species belonging to *Stemonitis*, *Lamproderma* and *Tubifera* are described in this paper.

contents: internodes thin, fine, paler coloured, up to 7 internodal threads given out from a node, about half of which join with other nodes while the rest remaining free. A few of the internodes also have brown foamy contents but the majority of them are homogeneous.

Spores deep brown in a mass, light brown under the microscope, rounded, almost smooth, 6 - 7 μ in diameter.

Plate I, Fig. 1., Text-Fig. 1, A–B.

Collected on rotten wood, rotten roots, and dead mosses, Kempty Fall, Mussoorie, Sept. 8, 1952, 89. New record in India.

The species is characterized by long-stipitate brown sporangia, very small calyculus represented by ribs and delicate peridial net with numerous free threads.

27. *Cribraria languescens* Rex

f. *magnigranosus* f. nov.

Sporangia 0.4–0.5 mm. diam., fusce brunneis, notatus cum permagnus atrofuscus dictydine grana: stipitis usque 2 mm. longa, atropiceus: sporis 6 - 7 μ diam., pallide brunneis, quasi laevis: ad putridus truncus et vivus musci: India (Wood Stock School, Mussoorie, Sept. 3, 1952, 90).

Sporangia deep fawn to deep brown, 0.4–0.5 mm. in diameter, marked with very large and dark dictydine granules: stipe up to 2 mm. long, pitch black: spores light brown, almost smooth, 6–7 μ in diameter: rotten stumps and living mosses: India (Wood Stock School, Mussoorie, Sept. 3, 1952. 90).

Fructifications sporangiate.

Sporangia gregarious or scattered, long-stipitate, deep fawn to deep brown, globose, erect or bending, small, 0.4 - 0.5 mm. in diameter: stipe very long, erect or bending, jet black, slightly tapering upward, grooved throughout, up to 2 mm. long, i.e., up to 5 times the diameter of the sporangium: calyculus bell shaped, occupying about one-half of the sporangium and markedly ribbed, ribs radiating out from the top of the stipe and marked by abundant very large and dark dictydine granules which tend to arrange in longitudinal rows, the margin of the calyculus wavy, inside of the calyculus marked by numerous parallel transverse wavy lines: peridial network composed of nodes and internodes: nodes thick, flattened or angular, slightly elongated or irregular in shape and size and contain numerous, rounded, very large dark dictydine granules as in the calyculus: internodes thin, slender, brown, up to 7 internodal threads given out from one node, some of which join with other nodes while others remain free: *spores* deep brown in a mass, light brown under the microscope, rounded, almost smooth, 6 - 7μ in diameter.

Plate I, Fig. 2., Text Fig. 2, A–B.

Collected on rotten stumps and living mosses, Wood Stock School, Mussoorie, India, Sept. 3, 1952, 90. New record in India.

A very wide range of spore size (5 - 14 μ in diameter) was also observed in this material. This undoubtedly applied to imperfectly matured sporangia. The spores from a properly matured sporangium are very regularly 6–7 μ in diameter.

This collection is very close to *Cribraria languescens* Rex from which it differs chiefly in the very large dark dictydine granules in the calyculus and nodes. Hence it is regarded here as a new form of *C. languescens* and is named f. *magnigranosus* f. nov. characterized by the possession of very large dictydine granules.

28. *Dictydium cancellatum* (Batsch) Macbr.

Fructifications sporangiate.

Sporangia gregarious or scattered in large irregular patches, stipitate, brown to brownish purple, purple or violet black, globose, umbilicate at the tip, erect or nodding, up to 0.75 mm. in diameter: stipe very long, erect or bent, deep brown, purple or purple black, lighter-coloured at apex, tapering upward, conspicuously grooved throughout, up to 3 mm. long, i.e.; four times the diameter of the sporangium: hypothallus none: calyculus very small to inconspicuous, merely represented by a thin film connecting the ribs of the peridial net, film with an uneven margin and marked by numerous plasmodic granules: peridial net composed of numerous, thick, unbranched, brown to purple longitudinal ribs radiating from the top of the stipe: ribs brown to deep violet, with wavy margin: marked by numerous rounded deep purple plasmodic granules; interconnected by much paler, very fine, transverse parallel threads: run longitudinally and parallel, extending outward and then converging at the top where they merge into one another to form an apical, closed net.

Spores deep brown to purple or violet in a mass, light brown to light purple or light red under the microscope, rounded, almost smooth, with 2 - 4, or more, deep brown to dark coloured, large plasmodic or dictydine granules, 5 - 7 μ in diameter.

Plate I, Fig.3., Text-Fig.3,

Collected on rotten stumps, Jabber Khet, Mussoorie, Sept. 1,1951,91. On rotten stumps, Dhobi Ghat, Mussoorie, Aug. 26,1951,92. New record in India.

The species is characterized by the peridial net composed of parallel longitudinal ribs connected by delicate transverse parallel threads and merged at the tip into an apical net, variable colour of the fruit bodies,

long stipes, and the presence of large, dark dictydine granules. The collection n.91 possesses brown to deep brown fruit bodies while they are purple to violet black throughout in n.92. These colour variations are well within the range of the species.

ORDER: *Stemonitales*

29. *Diachea leucopodia* (Bull.) Rost.

Fructifications sporangiate.

Sporangia densely gregarious, stipitate, cream coloured in early stage, later on turning pink, reddish and ultimately navy blue to almost black with a metallic lustre, iridescent, cylindrical or ellipsoidal, obtuse at the top, up to 1 mm. long and up to 0.5 mm. broad: stipe erect, tapering upward, snow white, calcarious, calcarious matter consisting of rounded crystals of lime, up to 0.75 mm. long: hypothallus well developed, white, calcarious, usually venulose forming a conspicuous network over the substratum from which sporangia arise: peridium single, thin, membranous, iridescent: dehiscence irregular, usually the upper portion or the sides of the peridium rupturing while its lower portion remaining somewhat persistent.

Columella well developed, thick, cylindrical, tapering upward or not, white, calcarious, extending beyond half the height of the sporangium and often terminating just below the apex of the sporangium.

Capillitium arising from the entire columella, composed of branching and anastomosing slender, flexuous, brown threads which form an intricate network with numerous free ends, surface net lacking, paler at the extremeties.

Spores black in a mass, dull violet under the microscope, rounded, profusely but minutely verrucose, 7 - 10 μ in diameter.

Text Fig. 4,A.

Collected on dead leaves of *Quercus incana* and other plants as well as on green leaves of *Strobilanthes* species, The Park, Mussoorie, Aug.11, 1952, 93.

This beautiful species is commonly encountered in the Mussoorie Hills and is easily recognized by its snow white stipe and cylindrical sporangium.

30. *Diachea splendens* Peck

Fructifications sporangiate.

Sporangia gregarious, often confluent in the region of basal part of stipes, stipitate, navy blue to deep violet with metallic lustre, iridescent,

globose, 0.4 - 0.5 mm. in diameter: stipe erect, tapering upward, conical, snow white, calcarious, calcarious matter consisting of rounded crystals of lime, up to 0.8 mm. long, i. e., exceeding the height of the sporangium: hypothallus prominent, venulose forming a conspicuous white network from which the sporangia arise, calcarious: peridium thin, membranous, iridescent: dehiscence irregular, peridium rupturing at the top or sides while its lower portion remaining persistent.

Columella prominent, white, calcarious, cylindrical with obtuse apex, extending to the centre of the sporangium.

Capillitium arising from all over the columella, composed of branching and anastomosing slender, violet threads which form a network with numerous acute and hyaline free ends, surface net lacking.

Spores black in a mass, violet under the microscope, rounded, profusely and coarsely verrucose, warts dark, coarse and interconnected to form an incomplete reticulation, 9.5 - 10.5 μ in diameter (including the warts).

Text-Fig. 4, B-C.

Collected on dead leaves of *Berberis* sp., *Quercus incana,* and other plants, Burning Ghat, Mussoorie, Aug. 15, 1952, 94. New record in India.

A beautiful species commonly encountered in the Mussoorie Hills along with *Diachea leucopodia* (Bull.) Rost., and can be easily differentiated from the latter by its globose sporangia and coarsely papillate and subreticulate spores.

31. *Lamproderma Arcyrionema* Rost.

Fructifications sporangiate.

Sporangia gregarious or scattered, stipitate, erect, violet black, iridescent, globose, up to 0.5 mm. in diameter: stipe long, erect, rigid, narrow, black, thick or swollen at the base, gradually narrowing above, up to 0.7 mm. long: hypothallus well developed, reddish black: peridium shinning or silvery, thin, membranous, not evanescent: dehiscence irregular, by irregular rupturing of the peridium above while its lower part remaining persistent.

Columella prominent, black, cylindrical, reaching nearly the middle of the sporangium where it breaks up into thick robust primary branches of the capillitium.

Capillitium dense, composed of violaceous brown, flexuous, slender threads which frequently branch and anastomose to form a loose network resembling that of Arcyria (hence the name of species Arcyrionema), free ends few.

Spores black in a mass, violaceous under the microscope, rounded, very faintly verrucose, 6 - 7μ in diameter.

Plate II, Fig. 1, Text-Fig. 5,A.

Collected on dead leaves of *Quercus incana*, and dead leaves of a grass, Jabbar Khet, Mussoorie, Sept. 3, 1951,95. New record in India.

This species is rather uncommon in the Mussoorie Hills and is recognized by its iridescent sporangia, long stipes and columella dividing at the top into several main branches which further give rise to the capillitium, and very faintly verrucose spores.

32. *Lamproderma scintillans* (Berk. & Br.) Morgan

Fructifications sporangiate.

Sporangia gregarious or scattered, stipitate, erect, dark violaceous brown to violaceous black with silvery metallic or brassy lustre, iridescent, globose, up to 0.4 mm. in diameter: stipe long, erect, rigid, black, slightly swollen at the base but uniform in thickness above, up to 0.6 mm. long: hypothallus well developed, violaceous brown : peridium thin, iridescent, membranous, not evanescent: dehiscence irregular, peridium rupturing above while its basal portion remaining persistent and forming a ring around the stipe.

Columella prominent, black, cylindrical, reaching nearly the centre of the sporangium, swollen or clavate at the top where it directly gives rise to the capillitium.

Capillitium dense, composed of rigid, straight, deep violaceous threads which branch and anastomose sparingly but do not taper, paler coloured or hyaline to subhyaline at the acute apices as well as near the top of the columella.

Spores black in a mass, violaceous under the microscope, rounded, profusely and conspicuously verrucose, 7 - 8 μ in diameter (including the wart).

Plate II, Fig. 2; Text-Fig.5,B.

Collected on dead leaves of *Quercus incana* and green leaves of *Hedera helix* Linn., Dhobi Ghat, Mussoorie, Sept. 15, 1951, 96.

This species is easily differentiated from *Lamproderma Arcyrionema* Rost. by its capillitial threads arising directly from the summit of the columella and conspicuously verrucose spores.

Botany Department,

Panjab University,

Amritsar.

References

HAGELSTEIN, R. (1944) The Mycetozoa of North America. New York.

LISTER, A. AND G. LISTER. (1925) A Monograph of the Mycetozoa, 3rd, ed. London.

MACBRIDE, T. H. AND G. W. MARTIN. (1934) The Myxomycetes. New York.

MARTIN, G. W. (1949) North American Flora 1 : 1 (Myxomycetes), The New York Botanical Garden, 1949.

MARTIN, G. W., K. S. THIND AND H. S. SOHI. (1956) The Myxomycetes of the Mussoorie Hills - IV. *Mycologia* (in press).

THIND, K. S. AND H. S. SOHI. (1955) The Myxomycetes of the Mussoorie Hills - I. *Indian Phytopathology* **8**: **150 - 159**.

—————— (1956) The Myxomycetes of the Mussoorie Hills - II. *Indian Phytopathology* **9**: 1 - 8.

—————— (1956) The Myxomycetes of the Mussoorie Hills - III. *Indian Phytopathology* 9(2) : 6 - 15.

Explanation of Plate I

Fig. 1 *Cribraria dictydioides* Cooke & Balf., A long-stipitate sporangium showing the small calyculus represented by ribs and the peridial net.

Fig. 2. *Cribraria languescens* Rex f. *magnigranosus* f. nov. A long stipitate sporangium showing the large calyculus and the peridial net.

Fig. 3. *Dictydium cancellatum* (Batsch) Macbr., A long-stipitate sporangium showing inconspicuous calyculus and the peridial net.

Fig. 4. *Diachea leucopodia* (Bull.) Rost., A short-stipitate sporangium showing the capillitial network and the columella extending beyond half the height of the sporangium.

Explanation of Plate 2

Fig. 5. *Lamproderma Arcyrionema* Rost., A stipitate sporangium showing the columella breaking up into thick robust primary branches which by further branching and anastomosing form a loose capilllitial network.

Fig. 6. *Lamproderma scintillans* (Berk. & Br.) Morgan, A stipitate sporangium showing the capillitial threads arising directly from the top of the columella (without the columella first giving rise to primary branches).

Text-Fig. 1 *Cribraria dictydioides* Cooke and Balf., A. Capillitium, X 380, B. Spores, X 880

Text-Fig. 2 *Cribraria languescens* Rex f. *magnigranosus* f. nov., A. Caplllitium, X 380 B. Spores, X 880

Text-Fig. 3 Dictydium cancellatum (Batsch) Macbr., A Spores with large and dark dictydine granules, X 880

Text-Fig. 4 *Diachea leucopodia* (Bull.) Rost., A. Profusely and minutely verrucose spores, X 880 *Diachea splendens* Peck, B Profusely and coarsely verrucose spores with warts interconnected to form an incomplete reticulation, X 880 C. Rounded crystals of lime from the calcarious stipe, X 880

Text-Fig. 5 *Lamproderma arcyrionema* Rost., A. Very faintly verruculose spores, X 880 *Lamproderma scintillans* (Berk. & Br.) Morgan, B. Profusely and conspiuously verrucose spores, X 880

PLATE 1

Fig. 1

Fig. 2

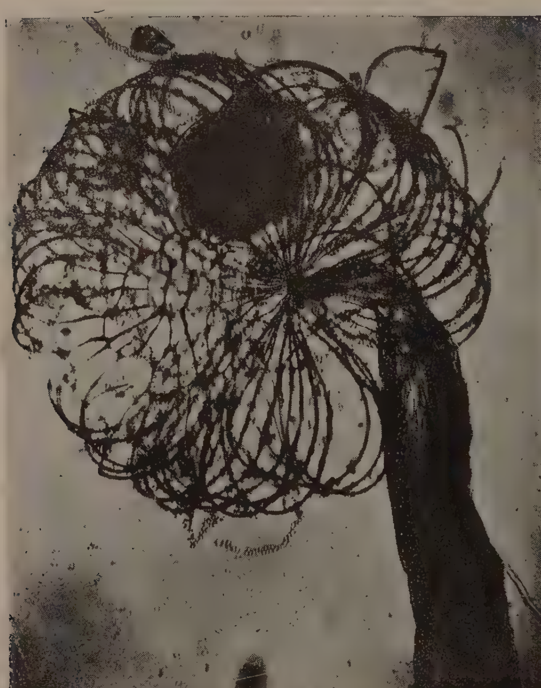


Fig. 3

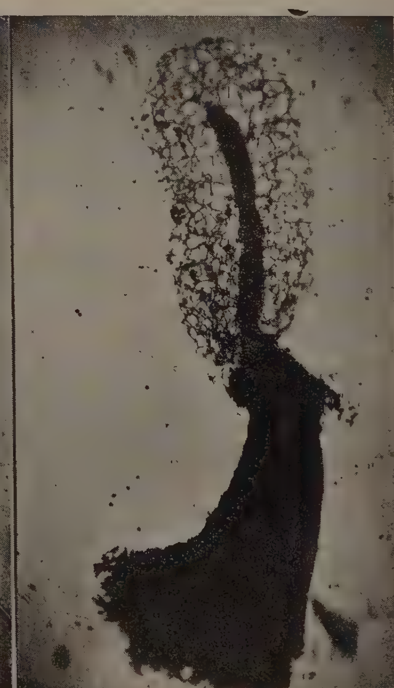


Fig. 4

PLATE 2

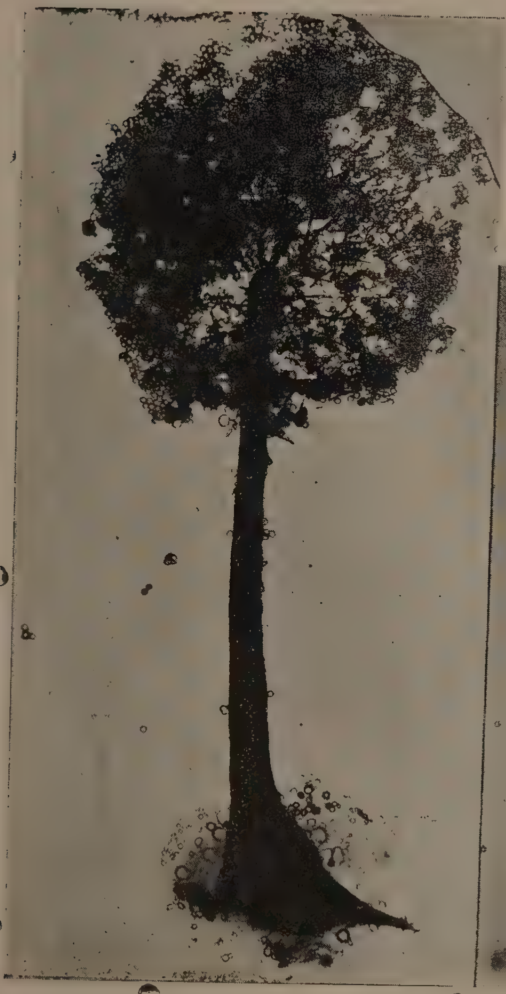


Fig. 5

Fig. 6

TEXT FIGURES

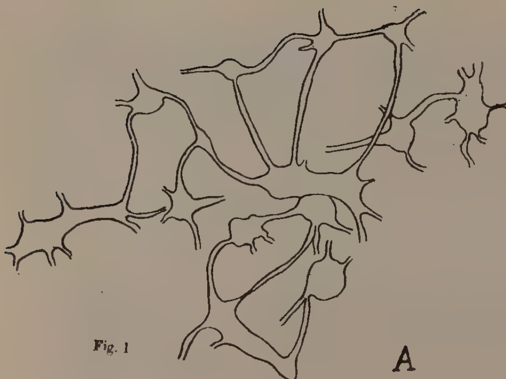


Fig. 1 A

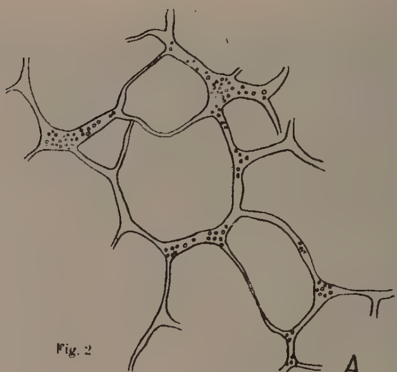


Fig. 2 A

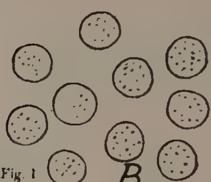


Fig. 1 B

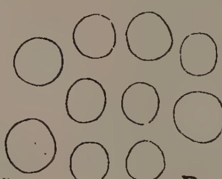


Fig. 2 B

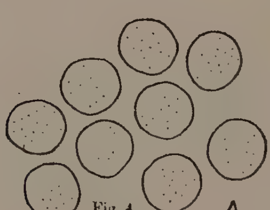


Fig. 4 A

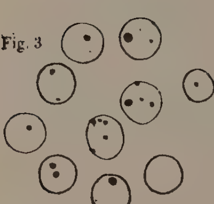


Fig. 3

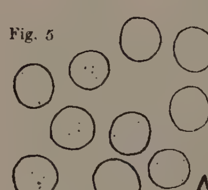


Fig. 5 A

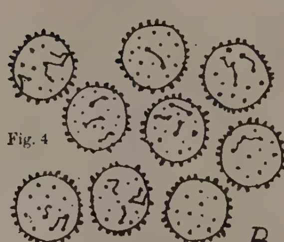


Fig. 4 B

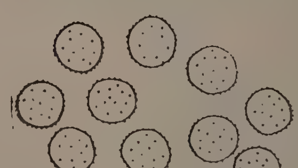


Fig. 5 B

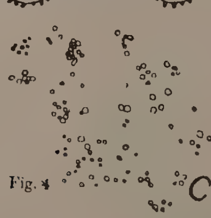


Fig. 4 C

DISEASES OF COTTON IN BOMBAY

II. HELMINTHOSPORIUM LEAFSPOT.

M. S. Rane and M. K. Patel

(Accepted for publication May 21, 1956)

Introduction

Although during 1948, *Helminthosporium* leaf spot was slight on *Gossypium herbaceum*, *G. hirsutum* and tree cottons, it became severe especially on *G. herbaceum* in December, 1951 at Dharwar. It affects mostly the lower leaves and bracts causing defoliation. Many a time, this disease is associated with *Alternaria* disease on tree cottons. The disease, being of minor importance does not seem to have been recorded in India so far since the reduction in yield is not heavy.

Symptoms

The disease usually appears on lower leaves and some-times on bracts as numerous, circular, light brown spots measuring 0.5 to 2.5 mm. (Fig. I–A). These spots later turn ashy in the centre with dark purple ring around. As the spots get older, the central tissue often falls out leaving holes in the leaves. Early defoliation ensues when the infection is severe. Although the infection is not observed on bolls in nature, it is brought about under artificial conditions of infection in the form of small, dot-like, purplish lesions.

Infection Experiment

A number of isolations made in the usual manner yielded a *Helminthosporium* sp. which was used for further studies.

Typical lesions with concentric rings appeared on leaves three days after inoculation. Control plants remained healthy. Reisolations made from infected leaves yielded the fungus resembling the original culture.

Infection experiments under the most optimum conditions have shown that *Gossypium arboreum*, *G. barbadense*, *G. herbaceum*, *G. hirsutum* and *G. purpurescens* are susceptible whereas plants belonging to Malvaceae, such as *Abutilon indicum* Sweet, *Althea rosea* Cav., *Hisbiscus cannabinus* L., *H. esculentus* L., *H. sabdariffa* L., *H. sabsdariffa* var. *altissima* L., *H. tetraphyllus* Roxb. and *Sida rhombifolia* var. *retusa* L. gave negative results.

Of the *Gossypium* spp., the following varieties viz. Moco belonging to *purpurascens* group; kidney cotton, sakel and Sea Island belonging to *brabadense* group; Jinjiya, Kampala, 4F–98, Laxmi and Co4–B–40 belonging to *hirsutum* group; Jaydhar, K.F., Suyog, G.A.26, Vijay, 1027 A.L.F. and

3652 belonging to *herbaceum* group and Ch. R–1 belonging to *arboreum* group showed moderate to severe infection while Co. 2 and Perso-American belonging to *hirsutum* group, 2266 and Wagad selections belonging to *herbaceum* group and N.M.D., Virnar, N.R.6, Dhulia 2, Gaorani 6 and Gaorani 12 of *arboreum* groupshowed slight infection.

Morphology

The following observations on the fungus grown on potato dextrose agar were recorded from a two week old culture grown at 27°C.

Mycelium:— The fungus produces profuse mycelial growth on potato dextrose, Richards', oatmeal, limabean and host decoction-dextrose agars. The mycelium when young is aerial, septate, hyaline and branched, turning light olive green when old. In older cultures, the mycelium becomes dark olive green near the substratum, the average width of hyphae being 6.4 μ. Branching is sparse and at acute angle.

Conidiophores:— Conidiophores are erect in most cases, emerging singly, bulbous at the base with prominent geniculations, bearing conidia at the tip or at different points in acropetal succession. The conidiophores measure 37 to 178 μ with 1 to 6 septa. Conidiophores arise singly or in group from stomata or from epidermal cells of diseased leaves.

Conidia:— In culture, they are borne singly or in clusters of 1 to 5 at the tip or at different points on the conidiophores in acropetal succession. They are thick walled, sub-cylindrical or ovate, rarely obclavate; singly curved and bent, and in, a few cases, straight, wider near the centre and gradually tapering towards the round off ends (Fig. 1–B). These measure 29.7–133.1 x 10.6–22.9 μ, the average being 76.4 x 16.9 μ. The number of septa varies from **3** to 10, usually 5 to 9, mostly 7.

Cultural Characters

The germination of the conidia is at its best at 26–27°C. and nil at 0 and 45°C. (Fig. 1–C), whereas the fungus growth is the best at 26–27 C. and nil at 0 and 40°C.

The fungus makes the best growth in Richards', lima bean, oat meal, potato dextrose and host decoction dextrose agars and moderate in the host decoction and Brown's synthetic agars while poor in plain agar.

The fungus produces emulsin, amidase, erepsin, cytase, trypsin, gelatinase, lipase and diastase.

The fungus makes best growth in dextrin, levulose, maltose, raffinose, starch and xylose; moderate in dextrose, galactose, inulin, lactose, mannitol, sucrose and poor in arabinose, dulcitol and salicin. Sporulation is observed only in dextrose, inulin, lactose, mannitol and raffinose.

The fungus grows profusely in potassium nitrate, alanine, asparagine, guanidine-hydrochloride, glycine, novleucine, peptone and proteose-peptone;

moderately on ammonium nitrate, ammonium sulphate, ammonium tartarate, arginine, glycocyanine, tryptophane and urea; poorly in ammonium phosphate, creatine, glutamic acid, methionine, norvaline and tyrosine while in sodium nitrite, the growth is inhibited. Though the nitrogen sources help the vegetative growth, they do not aid sporulation.

The fungus can grow in a wide range of H-ion concentration, growth decreasing in high acidity and alkalinity. The range of optimum reaction lies between 4.2 and 5.8 pH and, in general, the amount of aerial mycelium is greater in acid than in alkali reaction.

The disease appeared every year from December to February since 1951. Affected leaves collected at Dharwar in February 1953 and isolations made every month upto November, 1953, yielded the pathogenic fungus resembling the original culture, thus showing that the infected leaves of the previous season serve as a source of primary infection for the next season.

Review of Literature, Taxonomy and Nomenclature of the Fungus

The disease is of common occurrence in all the cotton growing areas of the world. Tucker (1926) was probably the first to investigate the disease in detail naming the pathogen, *Helminthosporium gossypii* Tucker. The disease was found on leaves, bracts, bolls etc. of *G. barbadense* grown on a commercial scale in Porto Rico. Stanner (1928) in Belgian Congo, Abbott (1929) and Rada (1935) in Peru, Comus (1934) and Clara (1935) in the Philippines reported the same disease.

Clara (1935) also studied the disease in detail. Comparing the morphological characters of his isolate with *H. gossypii*, he observed a considerable variability in the size of conidia and conidiophores. He, however, considered his isolate indistinguishable from *H. gossypii* on account of the symptoms and growth characters in culture. The fungus under study also shows close resemblance to *H. gossypii* in respect of symptoms on the host and morphological and cultural characters of the pathogen. It is, therefore, considered to be *H. gossypii*.

Comparative measurements of spores of *H. gossypii*

Authority	Measurements in μ			No. of
	Length	Breadth	Average	septa
Tucker (1926)	35 to 118	11.7 to 18.4	87 x 15.3	1 to 8 usually 4 to 7.
Clara (1935)	77 to 164.6	12 to 16	115 x 14.3	...
Present work	29.7 to 133.1	10.6 to 22.9	76.4 x 16.9	3 to 10 usually 5 to 9 mostly 7.

Summary

Helminthosporium leaf spot of cotton occurs sporadically in Dharwar district of Bombay State from December to February as typical circular spots on leaves and bracts. The fungus remains viable in infected leaves from one crop season to another. It is restricted in its pathogenicity to *Gossypium* spp. grown in the State.

The morphology and cultural characters of the fungus are described. It is indistinguishable from *Helminthosporium gossypii* Tucker in respect of symptoms produced, morphology and cultural character .

Plant Pathological Laboratory,
College of Agriculture,
Poona 5.

References

Abbott, E. W. (1929). Diseases of economic plants in Peru. *Phytopath.*, **19** : 645–656.

Clara, F. M. (1935). A new disease of cotton (*Gossypium* sp.) in the Philippines. *Philipp. J. Agric.* 6:217–225. (Abstract in R.A.M. 14 : 755–756, 1935).

Comus, J.S. (1934). Annual Report of the Director of Plant Industry for fiscal year ending December, 1931 (Philippines) (Abstract in R.A.M. 15 : 80, 1936).

Rada, G. G. (1935). Principles enfermedades del Algodonero en el Peru circ. *Estal. exp. agric. Lima* **28**, 19. (Abstract in R.A.M. 15 : 18, 1936).

Stanner, P. (1928). Mycological Report on the cotton campaign of 1927 at Manyema and Kivu. *Bull. Agric Congo Belge.* **19** : 528–536 Abstract in R.A.M. 9 : 32, 1930).

Tucker, C. M. (1926). A leaf, bract and boll spot of Sea Island cotton caused by *Helminthosporium gossypii* n. sp. *J. Agri. Res.* **32** : 391–395.

Explanation of Fig. 1.

A. Leaf and bract infection.

B. Conidia.

C. Germinated conidia.

PLATE I

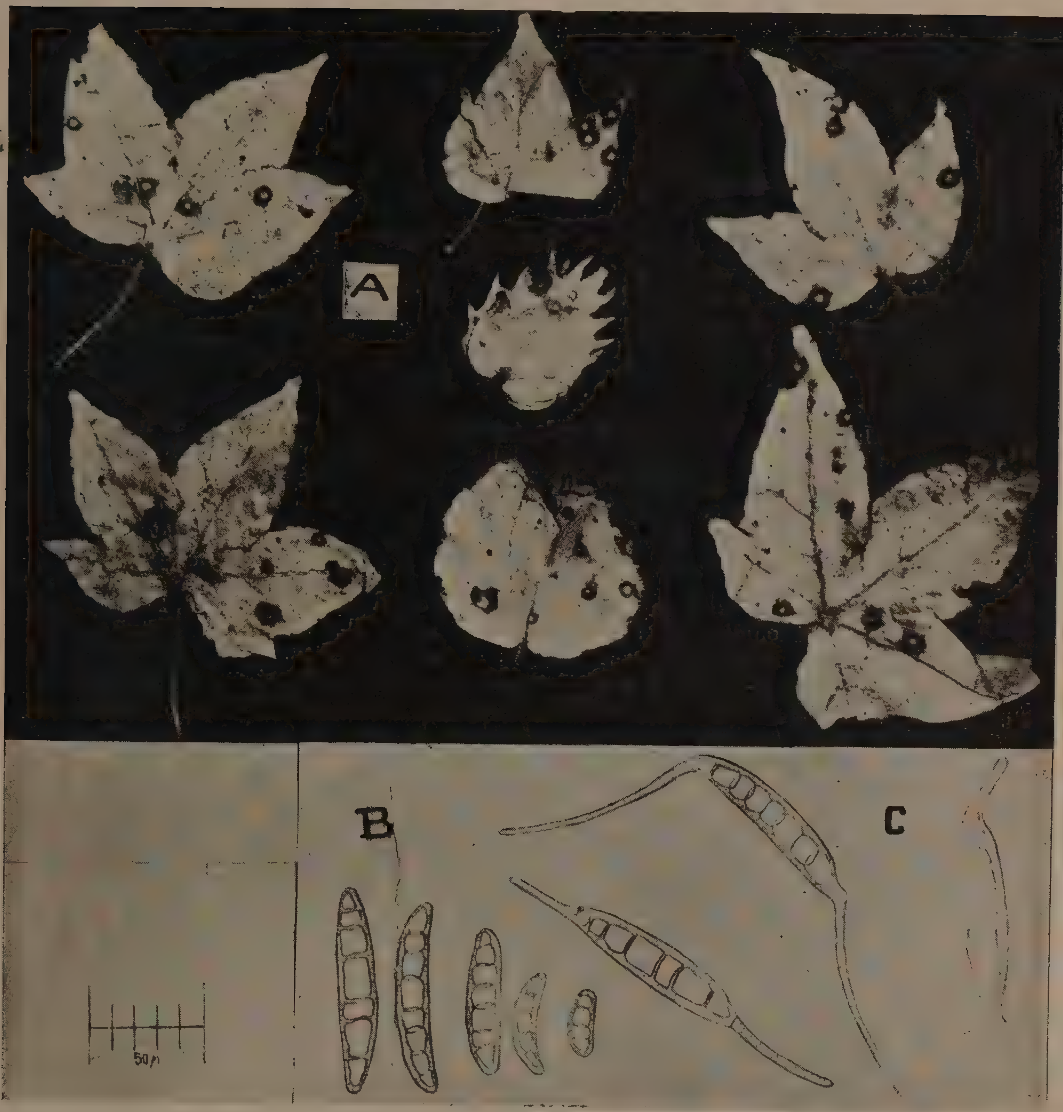


Fig. 1

ON A NEW LEAF SPOT DISEASE OF GAWAR (*CYAMOPSIS TETRAGONOLOBA* Taub) CAUSED BY *MYROTHECIUM RORIDUM* Tode Ex. Fr.

H. C. Arya

(Accepted for publication June, 15, 1956)

During August 1954 a new leaf spot disease of gawar (*Cyamopsis tetragonoloba* Taub) was found to occur at Balsamand gardens near Jodhpur. Further survey of the *gawar* fields revealed that the disease was wide spread in the whole area and under moist conditions was responsible for considerable damage. It was found to be prevalent on both the varieties of of *gawar*, the small field variety and the large garden variety.

The fungus, *Myrothecium* Tode, the causal agent of the disease has not so far been reported on *gawar*. The present paper deals with the studies on the various aspects of the fungus, its correct identification and the disease it causes.

Symptoms of the disease:

The symptoms of the disease are manifested on all the aerial parts of the plant including the stem, leaves and pods. The disease appears in the beginning as minute oil soaked spots of the size 1–2 m.m. in diameter. Within a day the spots become brown in colour and start enlarging in diameter. After three or four days, if suitable conditions of temperature and moisture continue to remain available, the spots become as large as 10–15 m.m. in size and give a characteristic target board type of appearance with distinct circular zonations. (Plate I, fig. 1.) If the leaf is infected at two or three places, the spots may coalesce and cover a fairly large area of leaf. The margin of the spots on the infected cotyledonous leaves is comparatively more prominently raised and pinkish in colour. The chlorosis around the spots is quite distinct.

The fructification is abundant under suitable environmental conditions. Synnemata appear in rings along the circular zonations. They are at first covered with a thin silavery membrane which later on flakes off making them erumpent.

In severe cases of infection, the entire infected leaf becomes cholorotic and ultimately gets defoliated. There have been cases when due to severe attack, majority of the leaves in the plant had fallen off.

Meterial and Methods.

The infected leaves of the local *gawar* variety were collected and preserved as herbarium material. Many collections were made from different localities in Jodhpur.

The fungus was isolated by directly picking up the conidia with inoculating needle from the synnema and transferring them to the potatos dextrose agar slants. The slants were incubated at 30°c. All the isolates yielded the same fungus. The fungus was purified by taking single spore cultures. For testing the pathogenicity local hairy variety of *gawar*, from which the fungus was isolated, was used.

Conidia from fifteen day old cultures were used for all kinds of studies. Inoculations were made by smearing the conidia on the stem, leaves and pods grown in pots without causing any injury. The experiments were always conducted in triplicates and the average of the readings was taken into consideration. The colony diameter of the cultures was measured in millimeters taking an average of the two diameters at right angles to each other. The structure of the synnema has been studied by cutting microtome sections of the leaf at 8 μ thickness and also by carefully removing them from the artificial culture for microscopic examination.

Fungus Morphology

Mycelium:

The mycelium of the fungus consists of slender, profusely branched, hyaline hyphae. The cells contain granular protoplasm with occasional presence of oil globules. The mycelium forms a thick weft growing at low temperatures; while at high temperatures it becomes very thin. There is no distinction between the vegetative and reproductive mycelia.

The mycelium inside the host plant is both inter and intracellular and ramifies in the parenchymatous tissues.

Synnemata:

The synnemata are pedicellate or sessile, discoid, flattened or circular and white rimmed structures in surface view. They measure 0.1 mm. to 1.0 m.m. in diameter, often become confluent into larger masses. They are white to green in the beginning, becoming jet black later on. The setae are absent. Synnemata arise from a pseudoparenchymatous stroma and erupt through the epidermal cells of the host. They are composed of the intertwinning conidiophores. The black thick viscid coating of the synnema at its wall is due to the aggregation of the conidial mass (Plate I, fig. 2).

Conidiophores:

These are erect, once or twice branched, septate and hyaline. The main axis is tapering, three to four celled and broadenning slightly below their distal septa. The basal cell measures about 28 x 2.5 μ and the apical cell about 10 x 1.5 μ. The branches of the conidiophores are one or two celled, arising either singly or in pairs or in whorls either directly from the terminal cell of the parent axis or immediately below the septum of an intermediate cell. Each branch of the conidiophore terminates in a whorl of phialides. The latter are clavate in whorls of two to eight at the apex of the main axis or its branches, but sometimes they also arise in small whorls immediately below a distal septum of an intermediate cell They

measure 5–8 x 1.5–2.0 μ. The phialides form a closely packed hymenium like layer in the synnema. (Plate I, fig. 3.)

Conidia:

The conidia are produced from a whorl of phialides and remain clustered together forming a dark black compact mass on the head of the synnema. The conidia are cylindrical, unicelled two guttulate with blunt ends. They are hyaline at first, becoming later pale green with a prominent black wall, measuring 5–7.5 x 1.5–2.0 μ with a mean 6.5 x 1.7 μ (Plate I fig. 4.)

Cultural characters:

The fungus was grown on a large number of media at a constant temperature of 29°C. The best surface growth with copious sporulation was obtained on Potato dextrose agar, Oat meal agar, czapek agar and Richard's agar. On corn meal agar mycelial growth was very thick but sporulation was poor. Similarly, Brown's synthetic agar gave a poor surface growth and sporulation.

In young cultures the mycelial threads are hyaline, separate and profusely branched; while a week old cultures start throwing out greenish black coloured synnmata in regular circular zonations.

The temperature range for the growth of the fungus is from 15 °C to 35 °C, obtaining an optimum at about 30 °C. The growth is inhibited at 37°C but when transferred to a lower temperature of 28°C the fungus regained it's capacity to grow. The influeuce of pH variations on the media have been studied, the fungus grows well at pH 4.5 to 8.5, obtaining an optimum at pH 7.5. This shows that the alkalinity of the medium was more favorable to growth.

Pathological Studies

Pathogenicity tests:

Pathogenicity of the fungus was tested at different stages of growth by the following methods.

1. Seed infections.
2. Seedling infection.
3. Inoculations of the leaves and pods of the adult plants.

Seed Infection:

Seed obtained from apparently healthy pods was surface sterilized by dipping it in 0.1 percent mercuric chloride solution for one minute and then washed thoroughly with sterilized water.

The seed was inoculated by placing conidial mass and sown in the pots containing sterilized soil. Equal number of uninoculated seed was

sown in another set of pots to serve as control. It was found that the germination of the seed was only 16.0 percent as against 93.0 percent in the control. Examination of the ungerminated seed among the inoculated series revealed rotting of the radicles and plumules due to fungal attack.

Cotyledonous leaves of the seedling and leaves and pods of the adult plants were inoculated by smearings them with conidia and incubating in a moist chamber at saturated humidity for twenty four hours. A successful infection was obtained with the development of characteristic lesions. However, it was found that the cotyledonous leaves of the seedlings were more susceptible, a fact which was reflected by the greater percentage of infection and larger lesions involving sometimes the entire area of the cotyledonous leaves. This is indicated in table 1 by +++. The pods were found to be comparatively more resistant to infection than the leaves. The results are recorded in table I.

Table 1.

Results of Inoculation tests conducted on the various parts of the Plant.

Treatment	Temperature in °C		No. of leaves or Pods		Percentage of Infection.	Intensity of infection.
	Minimum	Maximum	inoculated	infected		
Inoculation of the cotyledonous leaves.	26	32	40	40	100	+++
Inoculation of the leaves of the adult plants.	26	32	40	40	100	++
Inoculation of the Pods.	26	32	40	27	67.5	+

Influences of Temperature on the Intensity of Infection.

The influence of temperature on the intensity of infection was studied by making inoculations at intervals during the period from May, 1955 to April 1956. The results obtained are presented in table II. It is evident from the data obtained that for 100 percent infection the range of daily temperature is from 24°—43°C ; at low temperatures, however, during winter months from November to January the percentage of infection gets reduced and, at the same time, production of synnemata is also inhibited.

Table II.

Results of Inoculation tests conducted at different Temperatures on different Dates.

Date of inoculation.	Temperature (°C) Minimum	Temperature (°C) Maximum	No. of leaves. inoculated	No. of leaves. infected	Percentage of infection.	Remarks
4th May, '55	25	40	25	25	100	Synnemata
5th June, '55	31	43	25	25	100	developed.
10th July, '55	28	41	24	24	100	Dito
9th August, '55	26	32	30	30	100	"
11th S pt, '55	23	33	30	30	100	"
5th Oct, '55	23	31	30	30	100	"
19th Nov, '55	20	29	25	15	60	Synnemata
15th Dec, '55	12	24	20	7	35	not develop ed.
14th Jan, '56	7	21	20	5	25	"
22nd Feb, '56	17	30	24	14	58	"
5th March, '56	25	33	20	20	100	Synnemata
7th April, '56	25	32	20	20	100	developed.

Humidity seems to play an important role in determining the intensity of infection under optimum condition of temperatore, since exposure to saturated atmosphere for 24 hours gave cent percent infection. Exposure to 12 and 6 hours gave 69 and 60 percent infection, respectively. A prolonged exposure to 10 percent humidity for 40 hours although give cent percent infection, it adversely affected the health of the plants.

The influence of flaccidity of the leaves on infection was also studied. The plants prior to inoculation were subjected to drought conditions for 12 hours. It was found that the percentage of infection in such flaccid plants and fully turgid plants was 90 and 100, respectively. The lesions developed on the former were also comparatively very small.

Identity of the Fungus

Saccardo (1886)[1] was the first to give a definite description of the fungus *Myrothecium roridum* Tode Ex. Fr. in the terms, "sporodochia discoid or flat, black, white fringed, conidia cylindrical with blunt ends 8–10 x 2 μ (rarely 14 x2 μ), biguttulate, pale olivaceous". Later on Preston (1943)[2] elaborated upon this above description. while carrying out a detailed investigation of the genus Tode *Myrothecium* based on varisus isolates. His description of the *Myrothecium roridum* Tode Ex. Fr. runs as "sporodochia sessile, discoid, circular or irregular in surface view, often

1. Saccardo, (1886) Syllogue fungorum Vol IV, 750.
2. Preston, N.C., (1943) Observations on the genus Myrothecium Tode. The three classic species. Trans. Brit. Mycol. Soc. 26, 158-168.

confluent in larger masses, without setae, green at first becoming black white rimmed, conidia cylindrical or very slightly tapering with rounded cells, continuous, two to three guttulate, hyaline at first becoming pale green, 5–9 x 1–2.5 μ (average 8 x 2 μ), spore mass green becoming jet black".

Comparing the above description with that of the fungus under study, it is found that the organism is identical with *Myrothecium roridum* Tode Ex. Fr. with very minor differences like the occasional pedicellate nature of the synnemata and slightly smaller conidia. The organism is, therefore, identified as *Myrothecium roridum* Tode Ex. Fr.

Conclusion and Summary

The paper deals with a new leaf spot disease of *gawar* (*Cyamopsis tetragonoloba* Taub). The important symptom of the disease is the development of the target board type of brown to black coloured lesions on the leaves and pods and at the latter stage appearance of greenish black coloured confluent, erumpent synnemata in circular rings.

The morphology of the fungus has been studied in detail and the organism is identified as *Myrothecium roridum* Tode Ex. Fr. The pathogenicity tests reveal that the organism can cause damage to the host in all its stages, i.e., seed, seedling, leaves and pods of the adult plants.

The following factors were found to have a profound effect on the pathogenicity of the fungus.

(a) The first leaves (cotyledons) of seedlings are highly susceptible and the pods show some degree of resistance.

(b) High temperature conditions prevailing during summer months (25°—45°C) in North India, favour increase in the intensity of infection.

(c) A minimum period of 24 hours, under conditions of saturated atmosphere, is needed for cent percent infection.

(d) The plants with turgid leaves were found to be comparatively better infected.

The author wishes to express his sincere thanks to Mr. E. W. Mason, Mycologist, Commonwealth Mycological Institute, Kew, Surrey, England for giving valuable help in the identification of the fungus and also to Dr. K. M. Gupta, Head of the Department of Botany, Jaswant College, Jodhpur for his constructive criticism and help in the writing of the manuscript.

Dept. of Botany,
Jaswant College, Jodhpur.

Explanation of the Plate

Fig. 1 Infected leaf with abundant fuctification.

Fig. 2 Tranverse section of the infected leaf showing the attachment of the synnema.

Fig. 3 Conidisphore with Conidia attached.

Fig. 4 Conidia.

PLATE I

Fig : 1

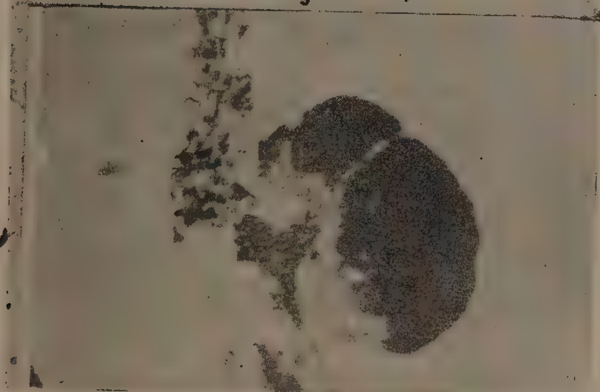


Fig. 2

Fig: 3

Fig. 4

OOSPORE GERMINATION OF SCLEROSPORA GRAMINICOLA (SACC.) SCHORET. ON BAJRA (PENNISETUM TYPHOIDES SATPF AND HUBB.)

D. SURYANARAYANA

(Accepted for publication June 15, 1956)

Butler (1918) stated that he could not germinate the oospores of *Sclerospora graminicola* on *bajra* in spite of repeated attempts. Chaudhuri (1932) reported that he successfully obtained the germination of the oospores, and according to him, they germinated by short germ tubes. Since his report, there is no other record of germination of these structures.

The writer while studying the effect of weathering upon the germination of the oospores of *Sclerospora* on *bajra*, had recently an occasion to observe good germination. The oospore material was collected from Bikaner in October, 1953. Dried leaves consisting of oospores were crumpled into small bits and sifted through muslin. The fine dust thus obtained consisted mostly of free oospores. A portion of the dust was kept in a packet inside the laboratory, while another was placed at the bottom of a small pot, covered with soil and exposed to the field conditions. In July, 1954, the material was taken out and tested for germination using Hiura's (1930) technique. About 50 per cent germination could be secured in the latter case, while cospores kept under the laboratory conditions gave only scanty germination. Oospores germinated by long hyaline germ tubes which were sometimes branched. Germ tubes were longer than those sketched by Chaudhuri and measured 274–480 μ in length. A few oospores produced two germ tubes instead of one. (Plates I and II).

From this, it appears that oospores require weathering under field conditions before they can germinate profusely. This perhaps explains the general observation that the oospores of *Sclerospora* on *bajra* do not germinate easily, as most of the workers may be using only laboratory-stored material which will not be mature enough for giving good germination.

Chaudhuri (I.C.) appears to have used material kept in the laboratory and the germ tubes produced by oospores from this collection were never long, although Evans and Harrar (1930) sketched long germ tubes in the case of the germinating oospores of *Sclerospora* on *Setaria*. The drawings presented in this note agree with those of Evans and Harrar. It has been observed sometimes that the germinating oospores (especially from the immature material like that stored inside the laboratory) produce only only small outgrowths instead of the normal germ tubes. From the figures, it seems that Chaudhuri has drawn some of those outgrowths which would have probably developed into normal germ tubes, had the material been properly matured.

The writer is indebted to Dr. R. S. Vasudeva, Ph.D., D. Sc. (London), Head of the Division of Mycology and Plant Pathology, for giving him

encouragement and necessary facilitaties for carrying out this investigation.

Division of Mycology and Plant Pathology,
Indian Agricultural Research Institute,
New Delhi.

References

BUTLER, E. J. (1918). Fungi and disease in plants. Thacker Spink & Co., Calcutta.

CHAUDHURI, H. (1932). *Sclerospora graminicola* on *bajra* (*Pennisetum typhoideum*). *Phytopathology*, **22** : 241–246.

EVANS, M. H. AND HARRAR, G. (1930). Germination of oospores of *Scleropora graminicola* (Sacc.) Schroet. *Phytopathology* **20** : 933–997.

HIURA, H. (1930). A simple method of germination of oospores of *Sclerospora graminicola*. *Science*, n. s., **72**, 95.

Explanation of the Plates

Plate I

Fig. 1. A germinating oospore. Two germ tubes, one long and one short, are seen. The long one branched at the tip. X 200.

Fig. 2. The same more magnified. X 400.

Plate II.

Fig. 1. Two germinating oospores; one of them with two germ tubes X 300

PLATE I

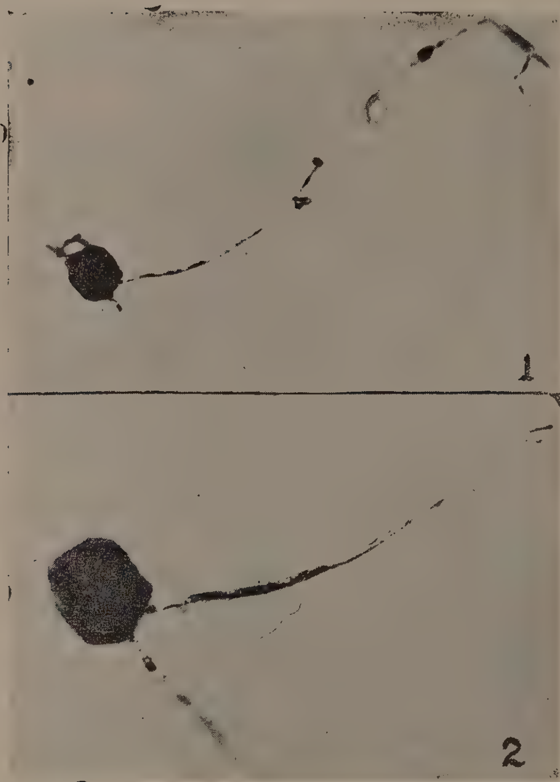


PLATE II

VASUDEVELLA, A NEW GENUS OF THE SPHAEROPSIDALES

B. L. Chona, R. L. Munjal and B. S. Bajaj

(Accepted for publication, June 15, 1956)

During the routine collections of plant disease specimens, blackish dot-like spots on the dried leaf-sheaths of *Sporobolus* sp. were observed at the Agricultural Research Sub-station, Karnal. The material, when examined, revealed the presence of pycnidia of a fungus characterised by hyaline, bi-celled or tri-celled spores with dichotomously branched cilia at the apex, thus indicating that it lies close to *Robillarda* Sacc., belonging to sub-family Hyalodidymae of Sphaeropsidaceae and order Sphaeropsidales, but differs from that in certain important taxonomic characters. It has not been possible for us to fit in this fungus in any of the known genera and, therefore, a new genus is proposed to accommodate this fungus. The name *Vasudevella* is proposed for it in honour of the present Chief of the Mycology and Plant Pathology Division of I.A.R.I., New Delhi, and an eminent Plant Pathologist.

The details of the studies made on this fungus are briefly described:

The fungus forms black dot-like fructifications which are of the size of pin head and are not formed on any localised discoloured spots. These are found scattered throughout on the leaf sheath, and occur mostly singly, rarely gregariously, in a linear fashion, thus appearing as elliptic black dots.

Development of the Pycnidium:

The mycelium of the fungus consists of septate hyaline hyphae, 0.75–1.5μ broad ramifying the tissues of leaf sheath except fibro-vascular bundles which the fungus is not able to penetrate. The affected host cells become distorted and delignified thus forming a cavity for the fungus to form its fructification. The protoplasmic contents of the hyphae become denser, turn olivaceous, and finally dark brown giving rise to stromatic globular mass which in due course becomes differentiated into a flask shaped pycnidium. The tissue of the pycnidium becomes differentiated: the outer wall being pseudo parenchymatous, dark brown and many layered thick; and the inner contents hyaline. The *Conidiophores* arise as short papillate hyaline single-structures from the inner wall of the pycnidium, these are pointed above, on which the conidial formation starts. The *conidia* are elliptic to slightly curved with tapering blunt ends and a cilium at the apex. The cilium is dichotomously branched.

Description of the Fungus:

Pycnidia are sub-epidermal, usually linear, formed in between the fibro-vascular bundles, carbonaceous, globose to conical (Fig. 1), measuring p80–247 x 105–165 μ (average 213 x 140 μ), dark brown with wall pseudo-larenchymatous, ostiolate; ostiole round, cells of the ostiole darker in colour

than the pycnidial wall. *Conidiophores* short elliptic, single celled, hyaline, pointed above, 5–7 μ in length, bearing conidia singly at the apex. *Conidia* single celled to start with, later bi-celled, rarely, tri-celled, not constricted at the septum, hyaline, elliptic to slightly curved, provided with a single, hyaline, dichotomously branched cilium only at the apical end. The conidia measure 15.8–24.5 x 3.5 μ (mostly 16–18 x 3.5 μ) and the cilia 15.8–24.5 μ (mostly 21.0 μ) in length. When a pycnidium is placed in water a cloudy dense mass of spores comes out of the ostiole.

Study of the Fungus in culture:

Studies on its spore germination and also on its characters on artificial culture media were made. It was observed that conidia germinate freely in water at a temperature of 15–25°C., the optimum being 22–25°C. No germination was observed below 10°C. or above 30°C. The germ tube may come out from one and or both the ends (Fig. 2). The spores started putting forth germ tubes in 6–8 hours' time at 22–25°C. in water.

The optimum temperature for the growth of this organism was observed to be 18–22°C. The fungus grows well on Oat Meal Agar* and Potato Dextrose Agar** media. The linear growth of the fungus was more rapid at higher temperatures than at the lower temperatures. The colonies of the fungus, about 3–4 mm. in diameter, were visible to the naked eye on the surface of the medium in the petri plate on the 4th day at 20°C. The mycelium was submerged and silky. Black dot-like structures were seen in the centre of each colony on the 6th day of its sub-culture, and after another 2 days, i.e. when the cultures were about 8 days old, a pinkish mass of spores started oozing of the pycnidium. The spore discharge was greater at a temperature of 22–25°C., while at 15–18°C. no oozing out of the spores from the Pycnidium took place. In the cultures kept at 22–25°C. cottony mycelium was more pre-dominent.

The fructifications were only partially embedded in the medium. They were more gregarious in habit as against their occuring singly on the host. It was also noted that the pycnidia in culture were bigger in size than those on the host, and measure 345–870 x 315–615 μ. The size of the conidia, however, remained unaffected, being 14.0–22.8 x 3.5 μ (mostly 16–18 x 3.5 μ), but there was an appreciable increase in the length of the cilia as compared to those on the host, measuring 24.5-31.5 μ (mostly 24–28 μ).

Taxonomic position:

The fungus is the member of the order Sphaeropsidales and family Sphaeropsidaceae. The spores are indistinctly bi-celled though the septum becomes quite prominent at the time of germination of spores. Very rarely a few bi-septate spores are also found. Therefore, the fungus has been

* Quaker White Oats	: 40 gms.		** Peeled Potatoes	:	250 gms.
Agar	: 20 gms.		Dextros	:	20 gms.
Distilled water	: 1000 c. c.		Agar	:	20 gms.
			Water	:	1000 c. c.

compared to other correlated genera of sub-families Hyalodidymae and Hyalophragmae. The fungus lies close in its morphology to *Neottiospora* Desm., *Robillarda* Sacc., *Kellermannia* Ell. & Ev. and *Bartalinia* Tassi, but differs from all these in its unique, dichotomously branching cilium. Considering the taxonomic importance of the cilium on the basis of which several genera have been classified, it is propcsed to erect a new genus, which is being named *Vasudevella*.

Vasudevella gen. nov.

Pycnidia sub-epidermal, scattered, single, globose to conical, shining, carbonaceous, unilocular, ostiolate, outer wall many layered, parenchymatous and sterile, inner wall hyaline and fertile, bearing sporophores. *Conidiophores* erect, short, single-celled, elliptic, hyaline, pointed above. *Conidia* bi-celled hyaline, elliptic, provided with a single, hyaline, dichotomously branched characteristic cilium only at the apex.

Vasudevella gen. nov.

Pycnidia subepidermalia, dispersa, singula, globosa vel conica, nitentia, carbonacea, unilocularia, ostiolata; parietes exteriores pluri-seriati, parenchymatici atque steriles, interiores vero hyalini atque fertiles,supportantes sporophoros. Conidiphori erecti, breves, unicellulati, elliptici, hyalini, acutisupra. conidia bicelluiata, hyalina. ellipitca, ornati unico cilio ad apicem hyalino, dichotome bifurcato characteristico.

Vesudevella sporoboli sp. nov.

Pycnidia sub-epidermal, black, dot-like, formed in-between the fibrovascular bundles, single, globose to conical, measuring 180–247 x 105 –165 μ, carbonaceous, shining, unilocular, ostiolate. Ostile round, cells of ostiole darker in colour than the pycnidial wall. Outer wall of pycnidium many layered, pseudo-parenchymatous and sterile, inner wall hyaline and fertile, bearing sporophores. *Conidiophores* short, elliptic, single-celled, hyaline, pointed above, 5 to 7 μ in length, bearing conidia singly at the apex. *Conidia* hyaline, bi-celled, rarely tri-celled, not constricted at the septum, elliptic, slightly convexo-concave, with tapering blunt ends, measuring 15.8–24.5 x 3.5 μ (mostly 16–18 x 3.5 μ), provided with single, hyaline, dichotomously branched characteristic cilium only at the apical end. Cilia measure 15.8–24.5 μ (mostly 21.0 μ).

On dried leaf-sheaths of *Sporobolus* sp., Agricultural Research Substation of I.A.R.I., Karnal, 3–10–1953 (B.S. Bajaj).

Type specimen deposited in Herb. Crypt. Ind. Orient., I.A.R.I., New Delhi (Acc. No. 23749) and culture deposited in the Indian Type Culture Collection, I.A.R.I., New Delhi (Gc. No. 957).

Vasudevella sporoboli spec. nov.

Pycnidia subepidermalia, nigra, punctis similia, insidentia inter fasciculos fibrovasculares, singul, globose vel conica, magnit. 180–247 x 105–165 μ, carbonacea, nitentia, unilocularia, ostiolata; ostiolo rotundo,

cellulae ostioli minores atque colore profundiores quam, parietales pycnidii, parietes exteriores pluriseriati parenchymatici atque steriles, interiores vero hyalini atque fertiles supportantes sporophoros. Conidiophori breves, elliptici, unicellulati, hyalini, acuti supra, 5–7 μ, conidia singula ad apicem supportantes. Conidia hyalina, bicellulata, raro tricellulata haud constricta ad septum elliptica, tenuiter convexo-concava, fastigata ad apices, magnit. 15.8–24.5 x 3.5 μ (ut plurimum 16–18 x 3.5 μ) ornata unico cilio characteristico dichotome bifurcato hyalino ad apicem. Ciliorum magnit. usque ad usque ad 15.8–24.5 μ (ut plurimum 21.0 μ).

In vaginis foliorum siccis *Sporoboli*, in Agric. Res.Sub-station I.A.R.I., Karnal, die 3 octobris 1953, (B.S. Bajaj). Typus positus in Herb. Crypt. Ind. Orient. I.A.R.I., New Delhi (Acc. No. 23749) eiusdem vero cultura posita in Ind. Type Cult. Coll., I.A.R.I., New Delhi (Gc. No. 957).

The authors take the opportunity of expressing their grateful thanks to Dr. R. S. Vasudeva, Head of the Division of Mycology and Plant Pathology, Indian Agricultural Research Institute, New Delhi for his keen interest and helpful criticism and for providing the necessary facilities of work. Thanks are also due to Rev. Father Dr. H. Santapau, Chief Botanist, Botanical Survey of India, Culcutta, for rendering the Latin diagnosis.

Division of Mycology and Plant Pathology,
Indian Agricultural Research Institute,
New Delhi—12.

Explanation of Figures

Fig. 1 A portion of leaf-sheath showing numerous dot-like pycnidia of *Vasudevella sporoboli* (Diagramatic)

Fig. 2 T.S. leaf-sheath showing a pycnidiun with conidiophores and conidia (Diagramatic).

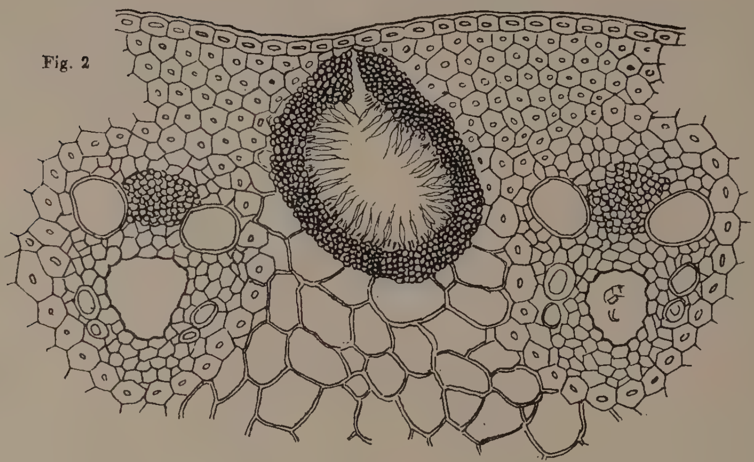
Fig. 3 Conidia of *Vasudevella sporoboli*.

TEXT FIGURES

Fig. 1

TEXT FIGURES

Fig. 2



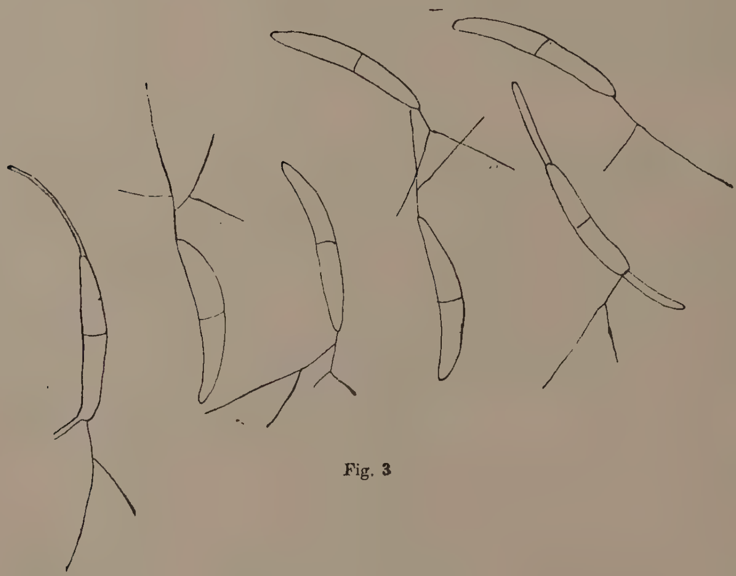


Fig. 3

OCCURRENCE OF *POLYPORUS SQUAMOSUS* (HUDS.) FR. IN INDIA

B. K. BAKSHI.

(Accepted for publication June 15, 1956)

Polyporus squamosus (Huds.) Fr. occurs widely in different parts of the world including Europe, America, Australia and India. The Indian record of the fungus is ancient (Butler & Bisby, 1931) and no collection of *P. squamosus* has been made for over 50 years. During tours taken in recent years in the Himalayas (Kulu division, Punjab), the fungus was collected on living trees of walnut (*Juglans regia*) and *Alnus nepalensis* and also on dead *Populus* sp. On the living walnut several sporophores of the fungus developed on a branch scar (Fig.1), about 20 feet from the ground, thus proving the usual role of the fungus as a wound parasite. *P. squamosus* causes considerable loss to trees and timber in Europe (Cartwright and Findlay, 1946). Its economic role in India has yet to be ascertained from a survey of the inaccessible temperate regions of the Himalayas where the fungus has been recorded. The fungus has not been described as it occurs in India. The following account gives a description of the fungus sporophores, the type of decay in wood, and cultural characters.

Sporophore:

Sporophore stipitate, stipe lateral or central (Figs. 2–4), 2–5 x 1–1.5 cm., pileus dimidiate, reniform, flabelliform or infundibuliform, solitary or imbricate, fleshy, drying corky, may shrink on drying, margin thick, entire; upper surface flat or somewhat centrally depresed, wrinkled on drying particularly at margins, 'pinkish buff',† conspicuously covered with scales (Fig. 2 and 3), big or small, appressed or raised and peeling off, with shades of 'carob brown', 'warm sepia', 'bister'; context 0.5–2 cm. thick, corky, white, drying 'light buff', hyphae hyaline, thin-walled, staining, branched, with simple septa and clamp connections (text-fig. a), 1.4–7.5 μ broad, or hyaline, thick-walled with lumen large or narrow, non-staining, sparsely branched, distantly septate (simple), 2–8.5 μ broad, often tapering abruptly (text-fig. b); hymenial surface white when fresh, 'pinkish buff' on drying, pores angular, 1–2 per mm., pore tubes upto 1 mm. long, basidia cylindric (text-fig. c), 17–20 x 6–8 μ; basidiospores hyaline, elongate, with indistinct apiculus (text-fig. d), 9–12 x 3.9–4.5 μ; hyphal pegs (text-fig. e) projecting into pore cavity, 35–45 x 22–35μ.

Specimens examined. On dead tree of *Juglans regia*. Pulga, Parbatty range, Kulu division, Punjab, June 1947, 4788*; on living *Alnus nepalensis* (locality as above), June 1947, 4798; on stump of *Populus* sp., Manali,

† Colours *within* '...........' are from Color standard and color nomenclature, by R. Ridgway.

* Numbers indicate herbarium numbers of specimens kept at Mycology Branch, Forest Research Institute, Dehra Dun.

Upper Kulu range, June 1955, 6517; on living *J. regia*, Jari, Parbatty range, Kulu, June 1955, 6518.

After gaining entrance into a tree through injury, the fungus travels into the heartwood and also attacks the sapwood. It produces a white spongy rot in the wood in which fine, black zone lines are produced (Fig. 2).

Cultural characters:

Growth characters. Growth very slow, radius 2–2.5 cm. in 4 weeks at 22°C in dark, mat white mixed with shades of 'buffy brown', 'sayal brown', 'snuff brown', appressed with scanty aerial mycelium which condense to form wide skin-like areas. Reverse deep brown. On gallic and tannic acid agars, diffusion zones very strong, growth nil. On gentian violet agar medium discoloured, growth moderate.

Hyphal characters. Aerial mycelium: (a) hyphae thin-walled, hyaline, rarely light brown with brown contents, branched with clamp connections (text-fig. f), 1.4–4.5 μ broad; (b) in skin-like areas, hyphae thin-walled or slightly thick-walled, dark brown, with numerous short irregular protuberances (text-fig. g), compactly arranged to form a pseudoparenchymatous layer. Submerged mycelium: hyphae thin-walled, hyaline, with clamp connections, 1–2.4 μ broad.

In most of the important features, the fungus agrees with *P. squamosus*. Some characters like clamps in the context hyphae and hyphal pegs observed in the present specimens are not described for *P. squamosus* but occurs in *Polyporus fagicola* Murr. which is regarded as a species closely allied to *P. squamosus* (Overholts, 1953). *P. squamosus* probably occurs in various forms. Graff (1936) discusses the synonymy of the fungus and considers *P. fagicola* as a variety of *P. squamosus*. In any case the habit and habitat of the fungus and the presence of large conspicuous scales on the pileus suggests it to belong to *P. squamosus*. In culture, the fungus agrees with *P. squamosus* in most features except that in the present isolate, oidia are not formed.

Mycology Branch,
Forest Research Institute & Colleges,
Dehra Dun.

References

Butler, E. J. and Bisby, G. R. (1931). The fungi of India, Calcutta.

Cartwright, K. St. G. and Findlay, W. P. K. (1946). Decay of timber and its prevention, London.

Graff, P. W. (1936). North American Polypores, *Mycologia*, **28**, 154–170.

Overholts, L. O. (1953). The Polyporaceae of the United States, Alaska and Canada, Ann. Arbor.

Explanations of text-figures

Fig. a. thin-walled context hypha with clamp; b, thick-walled context hyphae; c, basidium; d, basidiospores; e, hyphal peg; f, thin-walled hypha in culture; g. hypha from skin-like areas in culture. All figs. x 1300 except e, x 500.

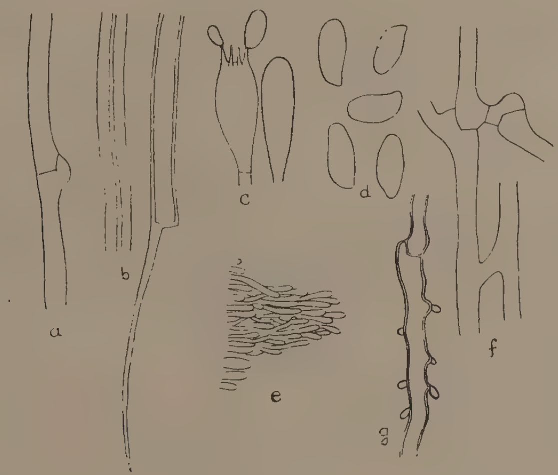
Explanation of Figures in Plate

Fig. 1. Sporophore (s) of *Polyporus squamosus* on wound caused due to breaking of a branch of a living walnut.

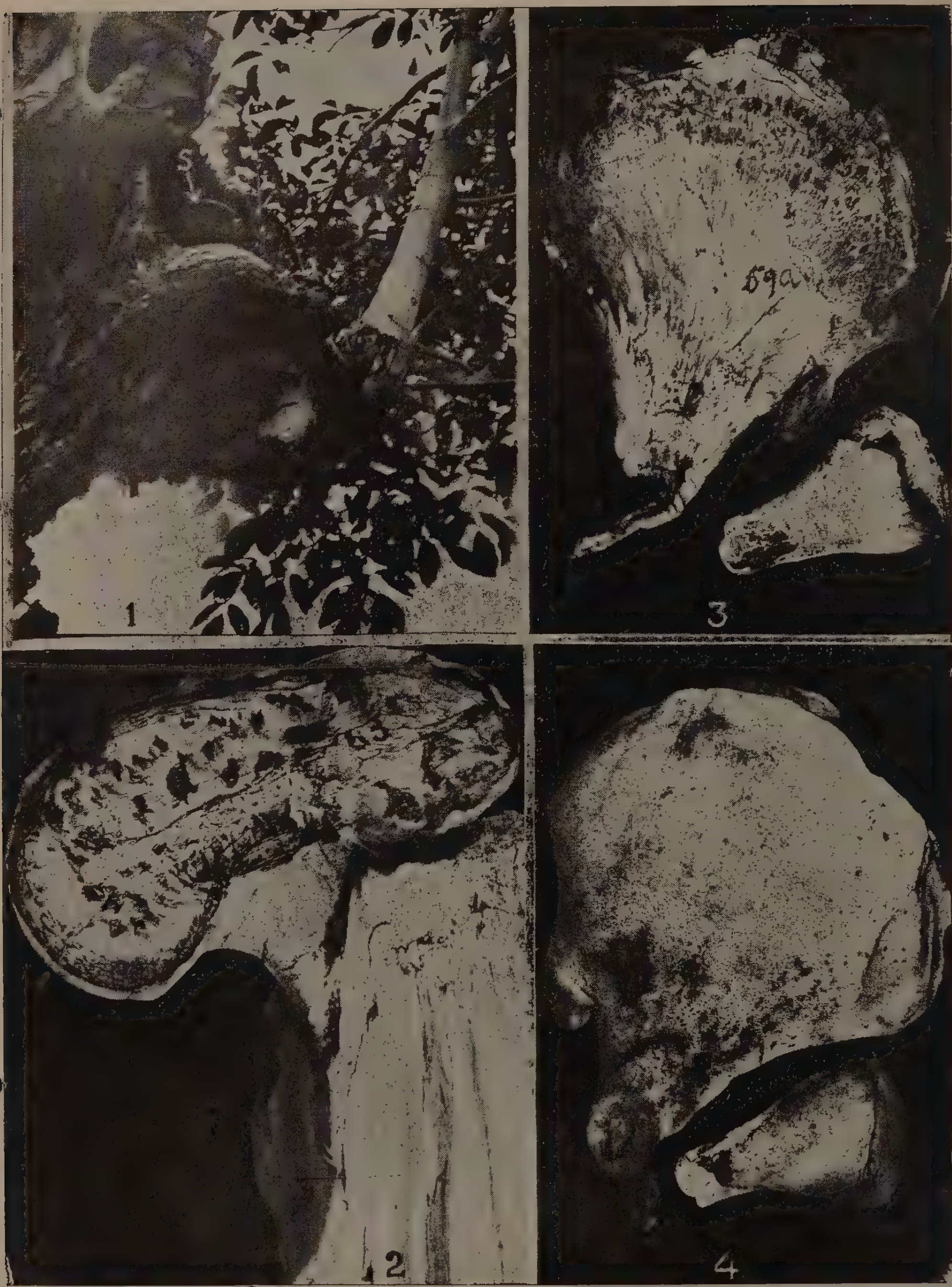
Fig. 2. *Polyporus squamosus*. upper surface. Also note the decayed wood with zone lines (x 2/3).

Fig. 3. *Polyporus squamosus*, upper surface (x 7/13).

Fig. 4. *Polyporus squamosus*, hymenial surface (x 7/13).



PLATE



BLIGHT DISEASE OF MANGO

M. K. Hingorani and O. P. Sharma

(Accepted for publication, June 26, 1956)

A blight disease of mango (*Mangifera indica* L.) was first observed in the Institute area during 1949 and subsequently found to be widely prevalent throughout Delhi State. The disease usually appears as yellowish pin-head like spots on leaves and twigs of the affected plants. These gradually enlarge discolouring the surrounded tissue, which first become biscuit coloured, then brown and dark brown with slightly raised and broad dark purplish margins, and later ashy coloured due to the appearance of pycr idia. Spots are round to start with, but later become oval or irregular, size depending upon the environmental conditions such as humidity, temperature *etc*. The spores that are washed down by rains accumulate as droplets at the tip of a leaf, which dries up entirely, and the infection travels dow ward toward the petiole. Sometimes half or more than half of a leaf may get involved. Pycnidia make their appearance mostly on the under-surface of the leaves, though sometimes on the upper su face too, as black dots scattered all over the necrotic portion. Dots are minute, mostly single, and innumerable. Infection is observed mainly on leaves and rarely on stems. On stems, the lesions are elliptic which later girdle the stem at the point of infection. On fruit, water-soaked, circular lesions are produced which enlarge rapidly and cause rot, particularly in storage. In field, however, fruit infection is rare under Delhi conditions.

Surface-sterilized diseased tissue, collected from different localities, yielded a species of *Macrophoma*. Its pathogenicity on mango plants, twigs and fruits was established and was further found to infect *Ficus carica*, *Fryobotrya japonica*, *Eugenia jambolina*, and *Vitis vinifera* in artificial inoculations. It was morphologically similar to the fungus described by Kanitkar and Uppal (1939) and Patel, Kamat a d Bhide (1949) from Bombay State. Since they did not name the fungus, which is different from the other known species of the genus *Macrophoma*, it is designated as *Macrophoma mangiferae* sp. nov. A brief description of the fungus, with its latin diagnosis, is given below.

Pycnidia amphigenous, mostly hypophyllus, innumerable, inate then erumpent, subepidermal, separate, irregular, appearing on the necrotic portion globose or subglobose, measuring 77 μ to 231 μ in diameter, wall ostiolate; ostiole circular and measures 7 μ to 17.5 μ in diameter; of the pycnidia 5–6 layers thick, parenchymatic; pycnidia deep-seated in the leaf tissue; conidiophores slender, hyaline, 8.0–11.0 x 1.5–2.0 μ bearing conidia singly on tips; conidia single-celled, hyaline oblong-elliptic, both ends rounded, slightly broader in the middle measuring

1 Kanitkar, U.K. and B.N. Uppal. Curr. Sc. 8, 10, 470-471, 1932.

2 Patel, M.K., M.N. Kamat and V.P. Bhide. Indian Phytopathology 2, 142-145, 1949

10.5–24.5 x 5.3–7.0 μ (average 19.8 x 6.5 μ), with granular contents, one to three oil drops. On living leaves of *Mangifera indica* L., Entomological area, IARI, New Delhi, 21. VIII. 1952 (M. K. Hingorani). Type specimen has been deposited at the Herb. Crypt. Ind. Orient., IARI, New Delhi, and culture in the Indian Type Culture Collection.

Pycnidia amphigena, ut plurimum hypophylla, plurima, innata, tum erumpentia, subepidermalia, separata, irregularia, fixa in parte necrotica, globosa vel subglobosa, magnitud. 77 μ to 231 μ diam., ostiolata; ostiolum circulare, magnitud. 7 μ to 17.5 μ diam.; parietes pycnidiales 5–6 seriati, parenchymatici; pycnidia alte infixa in textibus plantae hospitis: conidiophori tenues, hyalini, 8.0–11.0 x 1.5–2.0 μ, conidia singula supportantes ad apicem; conidia semel cellulata, hyalina, oblongo-ellipitica, rotundata ad utrumque apicem, paulo latiora ad medium, magnitud. 10.5–24.5 x 5.3–7.0 μ (medietate 19.8 x 6.5 μ), contentis granularibus, 1–3 olei globulis ornata. Typus lectus in foliis viventibus *Mangiferae indicae* Linn. in sectione entomologica in IARI in urbe New Delhi a M. K. Hingorani, die 21 mensis augusti anni 1952, et positus in Herb. Crypt. Ind. Orient. in IARI, New Delhi; typus vero cultus positus in Indian Type Culture Collection.

Detailed cultural and physiological studies of the pathogen have been done. The minimum, optimum and maximum temperatures for growth are 7°, 25–30° and 25–40°C., respectively. Acidic medium (pH 4.6 to 6.4) favours growth. The pathogen normally produces mature pycnidia sparsely after a prolonged incubation period (about 40 days), and that also on two media, namely, oat meal agar and Brown's medium. There is no pycnidial formation on majority of the other media tried and, in a few cases, some immature pycnidia may be observed. Exposure of the fungus to ultra-violet irradiation induces abundant sporulation within 7–10 days. Single spore isolations from the irradiated plates have yielded a mutant strain which is stable and different from the parent culture in having smaller pycnidia and spores as also in its ability to produce mature pycnidia in abundance within 7–10 days. In hostrange, however, it resembles the parent culture.

The writers are grateful to Dr. R. S. Vasudeva, Head of the Division of Mycology and Plant Pathology, IARI, New Delhi, for his helpful suggestions and for correcting the manuscript. They are also indebted to Rev. Father Dr. H. Santapa, St. Xavier's College, Bombay, for the latin diagnosis.

Division of Mycology and Plant Pathology,
Indian Agricultural Research Institute,
New Delhi.

A SPECIES OF *RHIZOPUS* CAUSING DRYING OF YOUNG FRUITS OF *CUCURBITA MAXIMA* L.

G. G. DALELA

(Accepted for publication July 4, 1956)

Developing young fruits of *Cucurbita maxima* L., growing in a private kitchen garden at Agra were noticed drying up during the months of April-May 1956. The examination of a number of such fruits in various stages of development revealed that the disease is caused by a species of *Rhizopus* which first attacks the fading perianth and then makes its way into the fruit through the stylar end. Quite abundant mycelium and sporangia were found in the fading female and male flowers and copious mycelium was detected in the tissues of the fruit. In a week's time of the fading of the flower the entire fruit dries up into a mummified form. Sometimes the fruits attain a diameter of 1–2" before being affected.

Rhizopus has been reported earlier by others to cause a soft rot of certain fruits, but in this case it appears that due to the prevailing hot weather in April–May the rot is of a dry nature. In large detatched fruits inoculated with the fungus and kept under a moist chamber a soft rot was. however, caused. It was also observed that the fungus produces a pectinase enzyme in the inoculated fruits as detected by Brown's Potato Disc method.

The fungus bears sporangia roughly spherical, black, measuring 66–115μ (mean 85μ, standard error $\pm 3.33\mu$) by 49–99μ (mean 73μ, standard error $\pm 2.93\mu$); columella hemispheri al; spores hyaline, sub-globose, measuring 6.6–11.6 μ (mean 9.5 μ, standard error ± 0.363 μ) by 5.0–8.25 μ (mean 6.93μ, standard error $\pm 0.264\mu$).

The original specimens are kept at the Herbarium of the Botany Department, Agra College, Agra and duplicates deposited at the Herb. Crypt. Ind. Orient. of Indian Agricultural Research Institute, New Delhi.

Botany Department,
Agra College, Agra.

CROSS INOCULATION STUDIES WITH SOME RHIZOBIA OF THE COWPEA GROUP

V. P. Bhide [1]

(Accepted for publication July 11, 1956)

The existence of cross-inoculation groups amongst the leguminous plants and their nodule bacteria is generally accepted by all workers. The cowpea group of legumes, where the organism responsible for nodulation has not been yet given a specific name, has been the subject of considerable research by various workers. Simon (1914) was the first investigator to recognise cross-inoculation groups amongst the legumes and he established five such groups, using 34 legume species distributed in seven genera. In the same year, German and Didlake (1914) established six cross-inoculation groups. Burrill and Hansen (1917) studied nine genera and seven species of the Leguminosae and recognised 11 groups. Walker (1928) showed seven groups representing 90 species and his grouping is generally accepted by all. Later, Walker and Brown (1935) recommended a merger of the cowpea and soybean groups with the name *Rhizobium japonicum* for the nodulating organism, since in their experiments, certain strains of the cowpea organism were able to nodulate soybean; this recommendation has not found favour with most of the workers in this field.

The number of leguminous plants included in the cowpea group is being constantly enlarged as work on this group progresses. Walker (1928) listed 33 species in this group; Fred, Baldwin and McCoy (1932) included 41 species; Carroll (1934) working on the legumes of Florida, increased this number to 64, 23 of the additions being species of *Crotalaria*, including *C. juncea*, (Sann-hemp), which had been formerly put in a group by itself by Walker (*ibid*). Allen and Allen (1936) studied nodule formation in a large number of tropical legumes in Hawaii and recommended addition of 30 species in 16 new genera and 57 species of previously placed genera, to the cowpea group.

In the present experiments, nodule organisms isolated from some Indian legumes were used for cross-inoculation experiments. Isolates of the nodule bacteria from the following plants were tested: *chavli* (*Vigna catjang*), groundnut (*Arachis hypogoea*), *mug* (*Phaseolus aureus*), *urid* (*Phaseolus radiatus*), sann-hemp (*Crotalaria juncea*), and *shevri* (*Sesbania aegyptiaca*); excepting *S. aegyptiaca*, the rest are authentic members of the cowpea group of legumes. The cross-inoculation tests were carried out in sand cultures using Crone's N-free nutrient solution. Two pots, each with five plants, were carried for each isolate of the organism and two uninoculated controls were provided for each host. The plants were allowed to grow for about six weeks and at the end of this period, each plant was carefully removed from the jar, its roots were washed free of sand in water, and the number of nodules on the tap and lateral roots were counted. Controls

1 Assistant Professor of Mycology, College of Agriculture, Poona.

grew poorly in all cases as did the inoculated plants where the bacteria had not established symbiosis

Experiment I.

This experiment was conducted in order to find out whether cross inoculation is possible between the nodule organisms from *chavli*, ground nut, *urid*, sann-hemp and *shevri*. The results (recorded in Table 1) show that all the isolates from *chavli* failed to nodulate groundnut and that *shevri* (*Sesbania aegyptiaca*) belongs to the cowpea group since its nodule organism produced nodules on *chavli* and *vice versa*. This plant has not been cited as a member of this group so far. The results also confirm the findings of Carroll (1934) in respect of the inclusion of sann-hemp (*Crotalaria juncea*) in the cowpea group of legumes.

Experiment II.

This experiment was carried out to dtermine the ability of the organisms under study to nodulate plants not included in the previous experiment and from which effective isolates of the organism were not on hand. The plants tested were *Desmodium diffusum*, *gram* (*Cicer arietinum*), *gawar* (*Cyamopsis tetragonoloba*), *kulthi* (*Dolichos biflorus*), lima bean (*Phaseolus lunatus-macrocarpus*), *matki* (*Phaseolus aconotifolius*), soybean (*Soja max*), *tur* (*Cajanus cajan*), and *wal* (*Dolichos lablab*). The technique of the experiment was the same as before and the results are recorded in Table 2.

Table 1.

Results of cross-inoculation tests with some members of the cowpea group.

Organism isolated from	Culture No	Average number of nodules produced on					
		Chavli	Ground-nut	*Mug*	*Udid*	Sann-hemp	*Shevri*
Chavli	A.I	10/4*	0/0	6/7	21/3	8/9	0/1
,,	A.II	7/4	0/0	6/	14/2	8/7	0/2
Groundnut	C	7/4	7/6	/2	10/3	0/9	3/1
Udid	D.I.	25/4	4/0	2/3	10/0	4/0	6/4
,,	D.II	6/4	8/0	0/3	12/2	2/1	3/2
Sann-hemp	E.I.	10/4	4/2	6/7	4/14	6/15	4/3
Mug	F.I.	10/5	2/0	3/2	3/2	0/3	2/3
,,	F.II	3/4	4/2	6/4	3/1	3/6	0/0
Shevri	G.I.	8/3	8/0	2/1	2/1	2/6	8/2
,,	G.II	3/2	6/3	3/3	3/2	2/6	8/3

* Number of nodules on tap and lateral roots respectively.

The results show that of the authentic members of the cowpea group included in this experiment, *kulthi* and *matki* were nodulated by all the organisms used *gawar*, *tur* and *wal* were nodulated by two isolates in each case, whereas lima was not nodulated by any of the isolates. Similar results were obtained by Carroll (1934) in respect of lima bean in his experiments with 23 cultures of the organism from members of the cowpea group, when only three of his 23 cultures nodulated lima bean.

Such irregularities are in keeping with the cowpea group of legumes, which, unlike the other cross-inoculation groups, is made up of a large number of unrelated genera and therefore presents a non-uniformity in respect of cross-inoculations.

Desmodium diffusum, as yet unclassified for its crossinoculation group can be included in the cowpea group, since it was nodulated by most of the cultures including those from *Chavli*.

The results with soybean are interesting. It was nodulated by cultures from four of the six members of the cowpea group under study, but the nodules were small, few, on the lateral roots and the plants did not seem to benefit by them. Walker and Brown (1935) recommended a merger of the soybean and cowpea groups. Carroll (1934) definitely placed the soybean in the cowpea group since he obtained nodules on soybean by many strains from cowpea. The present work also indicates that cross-inoculation between soybean and *chavli* is possible, but since the evidence on hand is not conclusive, no recommendations can be made. More work using a large number of strains from both the plants is necessary to settle this question.

TABLE 2

Nodulation of different leguminous plants by organisms from six members of the cowpea group.

Name of plant tested	Nodulation by organisms from					
	Chavli (*Vigna catjang*	Ground-nut (*Arachis hypogoea*)	*Udid* (*Phaseolus radiatus*	*Mug* (*Phaseolus aureus*	Sann-hemp (*Crotalaria juncea*)	*Shevri* (*Sesbania aegyptiaca*)
1. *Gawar* (*Cyamopsis tetragonoloba*)	—	+	+	—	—	—
2. *Kulthi* (*Dolichos biflorus*)	+	+	+	+	+	+
3. Lima bean (*Phaseolus lunatus-macrocarpus*)	—	—	—	—	—	—
4. *Matki* (*Phaseolus aconitifolius*)	+	+	+	+	+	+
5. *Tur* (*Cajanus cajan*)	—	+	+	—	—	—
6. *Wal* (*Dolichos lablab*	+	—	+	—	—	+
7. Soybean (*Soja max*)	+	—	+	+	+	—
8. *Gram* (*Cicer arietinum*)	—	—	—	—	—	—
9. *Desmodium diffusum*	+	—	+	+	+	+

Summary

In cross-inoculation experiments with root-nodule organisms from some members of the cowpea group, groundnut was not nodulated by two isolates from *chavli* (*Vigna catjang*) *shevri* (*Sesbania aegyptiaca*) was nodulated by organisms from all the cowpea group plants used and its own organism nodulated all the hosts, namely, *chavli*, groundnut, *udid* (*Phaseolus radiatus*), *mug* (*Phaseolus aureus*), and sann-hemp (*Crotalaria juncea*). It is, therefore, a new addition to the cowpea group.

Desmodium diffusum should also belong to the cowpea group since it was nodulated by organisms from authentic members of that group.

Soybean (*Soja max*) was also nodulated by organisms from members of the cowpea group indicating that cross-inoculations between the cowpea and soybean groups is possible.

References

Allen, O.N. and Allen, Ethel K. (1936). Root nodule bacteria some tropical leguminous plants. I. Cross-inoculation studies with *Vigna sinensis*. *Soil Sci.* **42** : 61-77.

Burrill, T. J. and Hansen, H. (1917). Is symbiosis possible between legume bacteria and non-legume plants? *III. Agri. Expt. Sta. Bul.* **202**.

Carroll, W. R. (1934). A study of Rhizobium sp. in relation to nodule formation on the roots of Florida legumes. I and II. *Soil Sci.* **37**: 117–135 and 227–242.

Fred, E. G., Baldwin, I.L. and McCoy, E. (1932). Root nodule bacteria and leguminous plants. *Uni. Wis. Stud. Sci.* **5** ; Uni. Wis. Press, Madison, Wisconsin.

German, H. and Didlake, M. (1914). Six different species of nodule bacteria. *Ky. Agri. Expt. Sta. Bul.* **184**.

Simon, J. (1914). Ueber die Verwandschaftsverhaltnisse der Leguminosen Wurzel-Bakterien. *Centbl. Bakt.* (II) **41** : 470–480. (Original not seen; cited by Fred *et al*, 1932).

Walker, R. H. (1928). Physiological studies on the nitrogen fixing bacteria of the genus Rhizobium. *Ia. Agri. Expt. Sta. Res. Bul.* **113**.

Walker, R. H. and Brown, P. E. (1935). The nomenclatuer of the cowpea group of root-nodule bacteria. *Soil Sci.* **39** ; 221–225.

AN INTERESTING DISEASE OF THEMEDA TREMULA

M. Kandaswamy and N. V. Sundaram

(Accepted for publication, July 11, 1956)

During the field observations made at the Agricultural Research Station, Ambalavayil (Wynaad) an interesting disease on the grass *Themeda tremula* was observed. Prominent glistening creamy exudations were seen produced on the lower surface of the leaves as well as on the leaf sheath and glumes. The infected specimens were collected and examined. The causal organism of the disease was found to be a new species of fungus belonging to the genus *Monochaetiella*. The type specimens are deposited in the Government Mycologist's Herbarium as well as in the Herb. Crypt. Ind. Orient. I.A.R.I., New Delhi.

Description of the disease.

Monochaetiella themedae sp. nov. Infection spots amphigenous, elongated, 1 to 2 mm. long and 0.5 to 1 mm. broad, light brown in colour; acervuli mostly hypophyllous, numerous 250–380 μ long and 52–60μ high, situated in the midddle of the spots, subepidermal, the epidermis being intact in the initial stages, later bursting open in narrow slits exposing the spores; conidiophores subepidermal, formed on the hyaline stroma made up of pseudoparenchymatous hyphal tissues, cylindrical with narrow ends, non-septate, hyaline, bearing one or more spores on each, measuring 10–19 x 2–4μ; conidia cylindric or fusoid, straight, hyaline tapering towards the base as well as the apex, contents granular, hyaline, smooth walled and thickened at the base, measuring 21 x 3 μ (15–28 x 2–4); cilia formed at the apex of the mature spores, hyaline, pointed and curved variously and measure 16.5 to 28μ long.

On living leaves, leaf sheath and glumes of *Themeda tremula* (Gramineae), Agricultural Research Station, Ambalavayil (Wynaad) 16–1–1955, N. V. Sundaram (Type).

Monochaetiella themedae spec. nov.

Infectionis maculae amphigenae, elongatae, 1—2 mm. longae, 0.5—1 mm. latae, pallide brunneae colore; acervuli ut plurimum hypophylli, plures 250 — 380 μ longi, 52—60 μ alti, positi in medio macularum, subepider males, epidermide primo intacta, tum erumpente in fissuras angustas atque sporas exponents. Conidiophori subedermales producti super stroma hyalinum constans textibus hyphalibus et pseudoparenchymaticis, cylin drici, apicibus angustatis, haud septati, hyalini, singulas pluresve sporas singuli supportantes, magnitudinis 10—19 x 2—4 μ. Conidia cylindrica vel fusoidea, recta, hyalina, fastigata tum ad basim tum ad apicem contentis granularibus hyalinis, levibus parietibus praedita et densat ad basim, magnitudinis 21 x 3 μ (15—28 x 2—4) poilia efformata ad apicem sporarum maturarum, hyalina, acuta, curvata varie et 16.5—28 J longa.

Typus lectus in foliis viventibus, foliorum vaniga et glumis *Themedae tremulae*, e familia, Gram'nearum, in loco Agricltural Research Station ad Ambalavayil, in provincia Wynaad, die 16 Januarii anni 1955 a N. V. Sundaram.

The disease spots are seen on both the surfaces of the leaves, leaf sheath and glumes but the acervuli are formed mostly on the lower surface of the leaves and on the outer surface of the leaf sheath and glumes. The acervuli are subepidermal and the epidermis in the initial stages of the infection remains covered but soon after it ruptures forming a slit like opening exposing the spore mass. The hyphae are hyaline, septate, up to 6μ thick found inter and intra-cellular. They collect below the epidermis forming a mat like pseudoparanchymatous layer. The conidiophores are arranged in a parrellel layer. Each conidiophore produces one or more conidia, the first being produced on the apex while the others are produced laterally. The conidia are cylindric or fusoid, slightly broader at the middle, with granular contents. The base of the conidium is much thickened and hyaline. The cilia are formed only when the spores are mature and they are mostly curved and pointed.

M. hyparrhenae Cast. has been recorded on *Hyparrhena rufae* (Kunth) stapf. from South Africa[1]. The fungus under study has smaller spores with much longer and pointed cilia than *M. hyparrhenae* besides having a thick hyaline base which is characteristic in this case and hence it is considered to be a new species. This is the second species recorded in this genus *Monochaetiella*. There is no recorded species of this genus so far in India.

ACKNOWLEDGEMENT

We are thankful to Dr. Ellis for having kindly identified the specimen and to the Director, Commonwealth Mycological Institute, Kew for having supplied the microfilm containing the description of *M. hyparrhenae*. Our thanks are also due to the Systematic Botanist and Professor of Botany, Agricultural College, Lawley Road Post, for the identification of the host plant. We are also thankful to Dr. H. Santapau for the Latin diagnosis.

Agricultural Research Institute
and College, Comibatore

1 CASTELLANI (1942). Nuovo G. Bot. Ital. N. S. XLIX p. 487, 1942 (Pub. 1943).

PLATE I

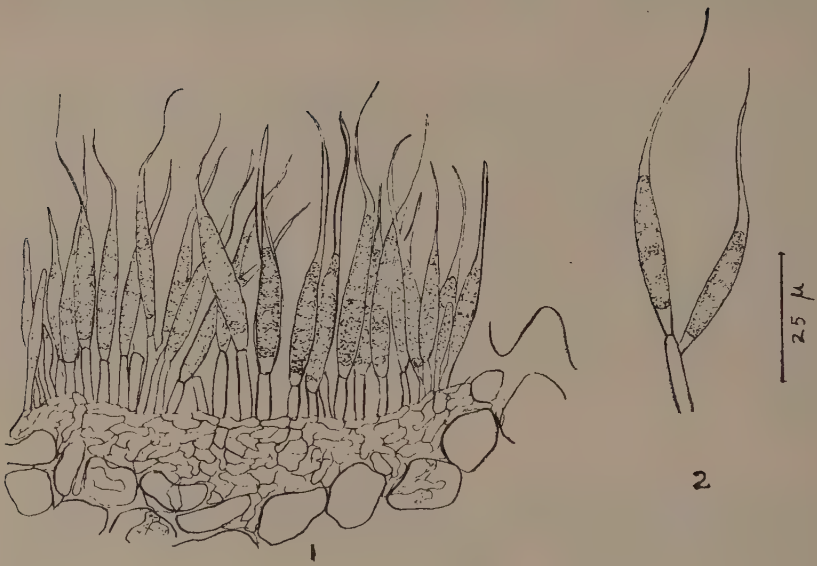


Fig. 1. Section of acervulus (portion) 2. Conidia.

FALSE SMUT ON *CHIONACHNE KOENIGII* THW.

P. Govindarao and G. S. Reddy

(Accepted for publication July 16, 1956)

False smut caused by *Ustilaginoidea virens* (Cke) Tak. is a common disease of paddy almost in all the rice growing parts of the world. Recently Govindarao and Reddy (1955) observed the incidence of false smut on wild paddy (*Oryza officinalis* Wall, and they considered the causal organism to be the same as *Ustilaginoidea virens.*

During November, 1955 a grass *Chionachne koenigii* Thw. growing on the paddy field bunds at Ambajipet, East Godavari district (Andhra State) was found affected with the false smut. Only two plants were found infected with the smut. The sclerotia measured 3 m.m x 3 m.m. and 4 m.m. x 2 m.m. Examination of the pseudosclerotial bodies revealed that the ovary of the flower alone is modified into sclerotium leaving the glumes unaffected. When the sclerotium is longitudinally cut and examined a whitish portion at the centre, an orange yellow layer next to it and a greenish outer layer consisting of dusty spore mass are observed. The mature spores are olive brown, conspicuously verrucose and round, measuring 5.9 μ (4.2–7.0 μ) in diameter. The comparative frequency of the spore measurements is given below:

Size of the spore		No. of spores
4.2 μ	—	4
5.6 μ	—	74
7.0 μ	—	22

Butler (1913) recorded the size of the spores of *U. virens* as 4-6 μ and occasionally elongated and 8x4 μ. According to Takahashi as quoted by Padwick (1950) the spore size is only 4-5 μ. The measurements of the spores from the pseudosclerotial bodies produced on *C. koenigii* in general agree with those recorded by the above authors on paddy.

The spores of the false smut on *C. keonigii* germinated readily in water and 1% sugar solution within 24 hours at about 29° C in the laboratory. The spores on germination produced a sepetate hyaline germ tube with conidial formation near the septae and tip. The conidia are single celled and oval to elliptic in shape (figure 1). Some times the conidia are produced in chains resembling the budding in yeasts. However, the cluster formation of the conidia at the tips of the germ tubes recorded by Butler (1913) in the case of *U. virens* on paddy could not be observed in the present specimen collected by the authors. The fungus could also be successfully brought into culture by keeping surface sterilized sclerotial bits in oat agar slants. The cultures grew as thick white masses at first and the same gradually turned yellowish or yellowish green in due course. However, typical formation of sclerotia was not observed in the culture tubes even after four months. Dr. S. P. Wiltshire, Director, Common-

wealth, Mycological Institute, Kew, Surrey, London, to whom the note was sent considered that the fungus is most probably *Ustilaginoidea virens* especially if the *Chionachne* was growing with infected paddy. Accordingly the fungus producing pseudosclerotia on *C. keonigii* is indentified as *Ustilaginoidea virens* (Cke) Tak.

A single sclerotial body with the host plant is sent to the Head of the Division of Mycology, Indian Agricultural Research Institute, New Delhi for deposition in his herbarium.

Acknowledgements

The authors are thankful to Sri. T. Venkataramana Reddy, Millet Specialist for kindly identifying the grass host and to Dr. S. P. Wiltshire, Director, The Commonwealth Mycological Institute, Kew, Surrey, London for his helpful suggestion in the naming of the parasite.

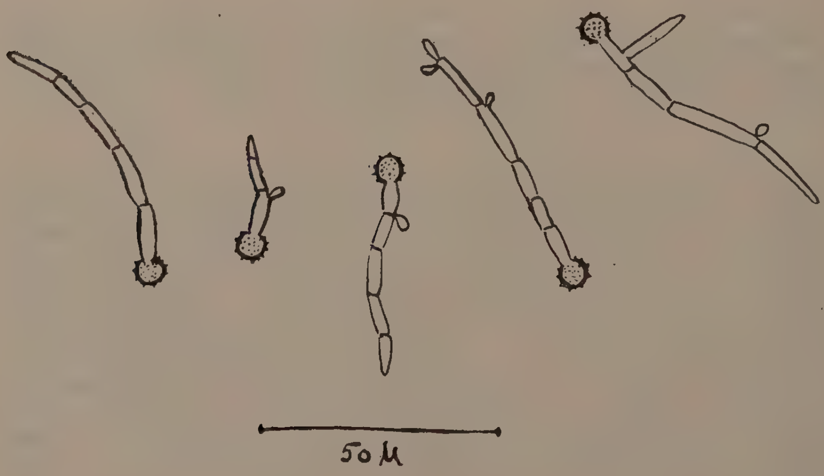
Mycology section,
Agricultural College,
Bapatla.

References.

Butler, E. J. (1913). Diseases of rice. *Agric. Res. Inst. Pusa Bull.* **34.**

Govindarao P. & Reddy T. C. V. (1955) Occurrence of *Ustilaginoidea virens* (Cke) Tak. on Oryza *offcinalis* Wall - *Indian Phytopath.* 8.:72-73.

Padwick G. W. (1950) Manual of rice diseases. *Commonwealth Mycological Institute, Kew.*



STUDIES ON THE NUTRITION OF *GLOEOSPORIUM PSIDII* (G. DEL.) SACC., THE INCITANT OF THE GUAVA (*PSIDIUM GUAJAVA L.*) ANTHRACNOSE

K. S. Thind and R. S. Sandhu

(Accepted for publication 15th June, 1956)

Gloeosporium psidii (G. Del.) Sacc. was isolated from the ripe guava fruits from different guava orchards around Amritsar City where it causes serious losses. Preliminary experiments were carried on Potato Dextrose Agar medium to define the optimum conditions for the growth of *G. psidii*. The fungus showed best growth at 24 – 28°C while its optimum pH range was found out to be 6 – 8.

Modified Duggar's solution was provisionally selected as the liquid medium for the growth of *G. psidii*. Its constituents were scrutinized as regards their optimum concentration for the growth of the fungus. Finally a basal medium was devised for studies on the nutrition of *G. psiddii*. The fungus showed a high tolerance for sugar concentration, giving still good growth even with 640 gms. dextrose per litre of the basal medium. The fungus did not respond to the addition of trace elements, vitamins and growth substances to the basal medium under the conditions of the present studies.

Sixty carbon compounds comprising 18 carbohydrates, 14 fatty acids, 16 amino-acids, and 18 miscellaneous compounds (alcohols, ketones, esters, fats etc.) were tested as sources of carbon for the growth of *G. psidii*. Out of the carbohydrates, L (–) arabinose, dextrose, fructose, L (–) sorbose, D (+) galactose, sucrose, aad starch gave good growth. All the fatty acids supported very little or no growth at all. Out of the amino-acids, Dl-analine, Di-aspartic acid, and L-glutamic acid proved to be better sources of carbon. The last two of these are held to play an important role in amino-acids synthesis of other fungi such as *Aspergillus niger*. All the miscellaneous compounds, except mannitol, supported very little or no growth at all.

Thirty-six nitrogenous compounds comprising 8 inorganic compounds, 23 amino-acids, and 5 other organic compounds were tested as sources of nitrogen for the growth of *G. psidii*. Out of the inorganic compounds nitrate nitrogen proved better source of nitrogen than the ammonium nitrogen for the growth of the fungus. Quite unexpectedly the fungus gave good growth on nitrites of sodium and potassium which usually inhibit the growth of fungi. Rarely do fungi give appreciable amount of growth on nitrites. Out of the amino acids, Dl-valine, Dl-pheny lalanine, andDl-aspartic acid gave best growth; Dl-alanine, Dl-serine, Dl-threonine, L-proline, and L-arginine also proved be good sources of nitrogen for the growth of the fungus. These amino-acids gave as good

growth as Potassium nitrate. However, p-amino-benzoic acid, indol-3-acetic and acid, 3-indolyl-butyric acid did not support the growth at all at the concentrations used.

The actual data on the nutrition of *G. psidii* along with necessary details will follow soon.

Botany Department,
Panjab University,
Amritsar.

IDENTIFICATION OF BIOTYPES WITHIN PHYSIOLOGIC RACES OF WHEAT STEM RUST

R. Prasada and K. R. Sreekantiah

(Accepted for publication September 25, 1956)

Introductory

Study of physiologic races in wheat rusts is important in several respects but chiefly for testing improved varieties for resistance to this disease. In almost every country a set of 12 differential hosts originally selected by Stakman and Levine (1922) from several hundred varieties of *Triticum* spp. have been used for physiologic race determination in stem rust, *Puccinia graminis tritici* (Pers.) Erikss. & Henn., and have proved fairly adequate for nearly 30 years. It has, however, been observed that different collections of the same race show distinct and consistent differences in the infection types within different classes of reaction, which though do not justify the creation of a new race, at the same time provide a clue to their separate genetic evolution. Moreover, some rust collections which behave identically on the standard differential hosts, at times show remarkable differences when tested on other varieties. This indicates that physiologic races as determined on the 12 standard differential hosts can be further subdivided into biotypes on the basis of their pathogenicity on additional wheat varieties, and it would become necessary to adopt supplementary differential hosts for their identification. It should, however, be realised that the possibilities in the direction of biotype identification are unlimited, since, with the addition of more and more varieties, a very large number of biotypes can be identified. The limiting factors in this direction are, the number of host varieties available for testing, and manpower and green-house accommodation which would be necessary for handling huge populations of rust collections and host varieties under different environmental conditions. Also from practical point of view this would become unmanageable.

It has been observed that different workers who have used the same race in their experiments do not get identical results. Whereas this could be partly due to diverse environmental conditions under which those experiments were performed, it is probable that they may have been dealing with different biotypes. Waterhouse and Waston (1941) have shown that race 34 of United States and race 34 of Australia are different in their host range and pathogenicity. In India, Uppal and Gokhale (1947) and Gokhale (1950) identified two new biotypes of race 42 and another of race 15 by the use of additional differential hosts. These biotypes are more virulent in their pathogenicity than the single spore cultures of these races originally isolated in 1932 and 1934 (Mehta, 1940). Several varieties which were resistant to the original races 15 and 42 have proved to be susceptible to these biotypes.

One single spore culture of each of the physiologic races so far isolated in India is being maintained at the Rust Research Laboratory, Simla, and these cultures have been used for testing wheat varieties. Since these

cultures represent only one biotype of these races, in view of what has been stated above, such tests cannot be expected to give a complete picture of their possible behaviour in the field where other biotypes may be present. Consequently, studies have been initiated in the direction of isolating commonly occurring biotypes with a view to utilizing them in subsequent varietal resistance tests.

Experimental

In these studies biotypes have been identified on the basis of their pathogenicity on a large number of indigenous and exotic wheat varieties that are available in the collection maintained in the Botany Division of this Institute. Rust collections taken from widely separated localities but yielding the same race on standard differential hosts were compared, on the basis of types of infection, with the single uredospore culture maintained at Simla. In the case of differential reaction on any variety, a single uredospore culture was established and retested on the standard differential hosts and that particular variety. After this confirmatory test the isolate was called a biotype of the race under study.

In the first instance physiologic race 21 was taken up because it appeared from its history that a new biotype was probably involved in recent rust collections. This race was picked up for the first time in India from a single collection from Lyallpur from 1933–34 wheat crop (Mehta, 1940) and was not found again till 1941–42; in subsequent years it gained in prevalence and accounted for 56.8, 61.3 and 46.9 per cent isolates in 1947–48, 1949–50 and 1951–52, respectively (Vasudeva et al, 1955).

Collections from widely separated localities, e.g., Mushobra (Simla hills) Pusa (Bihar) Kopargaon (Bombay State) and Delhi which yielded race 21 in recent years were compared, as regards their pathogenicity, with the original 350 generations old single spore culture which was taken from Lyallpur–C.518 in 1933–34. Tests were made on 127 varieties with all these cultures in the glass house under comparable conditions.

On the basis of these inoculations it was possible to identify another biotype of race 21 which was more virulent than the Lyallpur culture on three varieties, namely Benvenuto 3209, C.V. III–23–2419 and N. C. V. No. 2419 III 1931–25. On these varieties '3' or '4' type infection was produced by the four collections taken from Mushobra, Pusa, Kopargaon and Delhi whereas the Lyallpur culture produced resistant '2' type infection. These tests were repeated several times with the same results. Single uredospore culture was etablished from Pusa collection and after confirmatory tests labelled as biotype A of race 21. For ready comparison, types of infection produced by the different collections on supplementary differential varieties are given below:—

Name of the collection	Reaction of supplementary differential varieties		
	Benvenuto 3209	C.V. III-23–2419	N.C.V. No. 2419 III 1931–25
Lyallpur-Single spore culture Race 21	2	2	2
Kopargaon	3	4	4
Mushobra	3	4	4
Pusa	3	4	4*
Delhi	3	4	4

* Single spore culture from this isolate has been established to represent Race 21 biotype A.

ACKNOWLEDGMENTS

Grateful thanks are due to Dr. R. S. Vasudeva, Head of the Division of Mycology and Plant Pathology for initiating these studies, and guidance, and to Dr. S. M. Sikka, Head of the Division of Botany, for supplying seed of wheat varieties. Thanks are also due to Mr. M. H. Rao for suppyling the samples of rust and their maintenance.

SUMMARY

On the basis of their pathogenicity on three additional differential wheat varieties, a new biotype of *Puccinia graminis tritici* physiologic race 21, different from original single spore culture established from Lyallpur collection of year 1933-34, has been isolated from four rust samples taken in recent years from widely separated localities.

Dn. of Mycology & Plant Pathology,
Indian Agricultural Research Inst.,
New Delhi—12.

REFERENCES

GOKHALE, V. P. (1950) A new biotype of race 15 of *Puccinia graminis tritici*. *Curr. Sci.* 19:214–215.

MEHTA, K. C. (1940) Further studies on cereal rusts in India. *Sci. monogr.* 14, *Indian Counc. Agric. Res.*

STAKMAN, E. C. AND LEVINE, M. N. (1922) The determination of biologic forms of *Puccinia graminis* on *Triticum* spp. *Univ. Minn. Agric. Expt. Sta. Tech. Bull.* 10.

UPPAL, B. N. AND GOKHALE, V. P. (1947) A new race of *Puccinia graminis tritici* and two biotypes of race 42. *Curr. Sci.* 16 : 61.

VASUDEVA, R. S. ET AL (1955) Prevalence of physiologic races of wheat and barley rusts in India. *Indian Phytopathology* 8 : 22–55.

WATERHOUSE, W. L. AND WATSON, I. A. (1941) Australian Rust Studies. VI. Comparative studies of biotype of race 34 of *Puccinia graminis tritici*. *Proc. Linn. Soc.* N.S.W. 56 : 269—275.

PHYTOPATHOLOGICAL NOTE

A simple and inexpensive substitute for hypodermic syringe in field infection studies with wheat rusts—R. Prasada and L. M. Joshi. For varietal resistance tests with wheat rusts, the plants are inoculated in the glass house in the seedling stage and in the field in the adult stage. In the seedling tests each plant is inoculated with a flat needle but in the field, where epidemic conditions have to be reproduced over a large area involving thousands of plants, several methods have been used. Suspension of uredospores in water is sprayed on the test plants by means of an atomiser, or dry uredospores are mixed with talc power in the ratio of 1 : 500 and dusted with a hand blower. The plants so inoculated are then covered for 36 hours with cloth tents which are kept wet to ensure good infection. Where spore suspension in water was used it was found that a large proportion of inoculum was wasted in run off. Use of talc had the advantage of better coverage and talc absorbed moisture with the result that good uredospore germination was ensured. By both these methods, however, a continuous supply of inoculum to the plants during the entire testing period could not be maintained. The test plots are, therefore surrounded by rows of susceptible wheat varieties and these are sown, and inoculated with rust spores a few weeks in advance of the test plots so that plenty of inoculum is present in their immediate neighbourhood.

Various methods have been adopted for inoculating these infector rows. After spraying them with water suspension of spores or dusting them with talc-spore mixture, the plants are covered with wet cloth or sheet glass to ensure humidity for infection. Or, plants are inoculated in the boot by injecting spore suspension by means of a hypodermic syringe. Although by the latter method a good infection is ensured on account of sufficient humidity inside the boot, it proved to be a cumbersome process. Two workers were required, one to carry the spore suspension and the other to make inoculations and after every few inoculation it was necessary to refill the syringe since it would take only a few c.c. of inoculum at a time. Above all, the costly syringe broke frequently in the hands of a field worker; and the operation was found to be highly time consuming where huge plant populations had to be handled within a limited period. Pitkin syringe has been used in other countries to overcome some of these disadvantages of hypodermic syringe.

A simple and inexpensive device to take the place of hypodermic or Pitkin syringe, is described in this paper and it can be made easily in the laboratory. One hard glass wash bottle 500 c.c. capacity is fitted with a tight fitting double bored rubber stopper provided with two glass tubes bent at 135° angle, one reaching the bottom of the bottle and the other ending just below the stopper. Thin bore rubber tubing is attached to the ends of glass tubes and their length adjusted according to requirement.

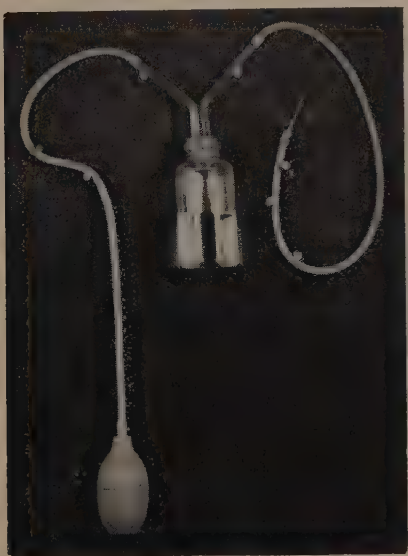
A hypodermic syringe needle is attached to the rubber tube connected with longer glass tube, and to the other rubber tube is fitted an

India rubber air blowing bulb. A photograph of the whole apparatus is shown in the plate. The bottle is filled 3/4 with spore suspension which had been strained through muslin to remove leaf tissues. The rubber stopper is firmly fitted on the bottle. All connections should be air-tight. The bottle is put in the pocket, and with one hand the needle is inserted in the boot and with the other by pressing the air blowing bulb a small quantity of spore suspension is introduced in the boot. By this method it is possible for one person to make a large number of inoculations rapidly without the necessity of frequent refillings. There is no costly part to break. At the most, the bottle if it breaks can be easily replaced.

The apparatus described here can be used in the case of bunt inoculations also. For its efficient performance, however, it is necessary that all fittings and connections are made air-tight.

Our thanks are due to Dr. R. S. Vasudeva for his helpful suggestions.

Dn. of Mycology & Plant Pathology
I.A.R.I., New Delhi.



IVTH INTERNATIONAL CONGRESS OF CROP PROTECTION 1957

The IVth International Congress of Crop Protection will be held in Hamburg, Germany, from the 8th to the 15th of September 1957. The second information, giving a detailed specification of the subjects to be discussed during the congress, has been posted lately. Papers shall be arranged on the wide field of phytopathology and crop protection, thus enabling a review on the progress made during these last 5 years. The following mentioned subjects shall be considered:

Fundamental research (general and special phytopathology)

Phytotherapy (control of diseases and pests)

Protection of stored products

Technique of crop protection (equipment for plant protection)

Plant quarantine

Organization of crop protection and legal regulations.

Interested persons who have not yet received the preceding circulars are requested to send in their address to the congress office.

Papers to be presented during the congress shall last no longer than 20 minutes. Visitors who intend to present a paper are asked to announce the topic before the 1st of April and to send in at the some time an extract of about one typed page. Lantern slides are allowed in the size of 5 x 5 mm. only; episcopical projection, however, will not be possible.

Visitors who were planning to attend the congress, and visitors who intend to deliver a paper are asked to cummunicate as soon as possible with the congress office. For any inquiry or information apply as well to the

congress office: Biologische Bundesanstalt für
Land - und Forstwirtschaft

Messeweg 11/12
Braunschweig/ Federal Union of Germany

The
4th International Congress of Crop Protection
will be held in Hamburg/Germany
from the 8th to the 15th of September 1957

The following subjects will be discussed:

A. Fundamental research: Diseases, causal agents, pests

I. General phytopathology and phytoparasitology, host-parasite problem

1. Resistance to diseases and pests
2. Pathological morphylogy, anatomy and physiology
3. Epidemiology, forecast, warning services
4. Non-parasitic diseases

II. Viruses and virus diseases

III. Diseases and injures caused by

1. Bacteria
2. Fungi
3. Higher plants including weeds (furthermore algae, lichens, mosses)

IV. Animal Pests

1. Nematodes
2. Mites
3. Insects
4. Molluscs
5. Vertebrates

B. Phytotherapy (Control of diseases and pests)

I. Hygienic and biological measures

II. Physical (mechanical) measures

III. Chemical measures (Phytopharmacy)

1. Physical properties of pesticides
2. Analytic-chemical methods for investigation of pesticides
3. Analytic-biological methods for investigation of pesticides
4. Biological effectiveness of pesticides
   (a) Insecticides, acaricides nematicides, mulluscicides
   (b) Fungicides
   (c) Herbicides and growth regulators
   (d) Rodenticides
   (e) Antibiotics
5. Economy of crop protection.

6. Secondary effects of pesticides
   (a) Phytotoxicity and effects on soil organisms
   (b) Toxicity for man and domestic animals
   (c) Residues of pesticides in foods and forages (tolerances)
   (d) Resistance of causal agents and pests

C. Protection of stored products

D. Technique of crop protection (Equipment for plant protection)

Sprayers, mist blowers, atomizers, vaporizers, seed treatment equipments, dusters and traps

E. Plant quarantine

F. Organization of crop protection and legal regulations

Not obligatory registration

Interested persons are requested to fill in the adjoined post-card and to send it immediately to the Bilologische Bundesanstalt in Braunschweig, if not done already. This card is wanted for the sending of the definite application forms for the participation in the congress.

Announcement of papers

In order to be able to arrange the definite sections and subsections for the congress program visitors are asked to announce as soon as possible, but not later than the 1st of April 1957, papers they wish to deliver within the a/m subjects also to the

Biologische Bundesanstalt
für Land-und Forstwirtschaft

Messweg 11/12

Braunschweig

The congress shall give a review of progress of the 5 years in plant protection work. Therefore the papers should contain only new results not yet published. The time for presentation should not exceed 20 minutes for each paper.

When announcing the topic of their paper visitors will kindlyi nform on the desired time for presentation and add an abstract of about one typed page.

Furthermore they are requested to announce if they want to show projection slides. Dias only will be admitted in the size of 5 x 5 cm.

Episcopical projection will not be possible.

INDIAN PHYTOPATHOLOGICAL SOCIETY

Instructions to Authors

Membership in the INDIAN PHYTOPATHOLOGICAL SOCIETY is pre-requisite to publishing in INDIAN PHYTOPATHOLOGY but the Editorial Board may relax this rule in the case of contributions of exceptional merit and communicated with a special recommendation by a member. The Editorial Board may invite distinguished scientists to contribute articles of interest to the Society.

Contributions should be on one side of the page, double spaced, with a 1¼th inch margin on the left. In form and style, such as punctuation, spelling and use of italics, the manuscript should conform to the best Journals in the U.K. and U.S.A. Authors should strive for a clear and concise style of writing. The name and address of the Institution at which the work was done should be cited immediately after the SUMMARY at the end of the article on left hand side. Tables should be numbered and each table should have a heading stating briefly its contents. References to literature should be made as foot notes *only* when four or fewer citations are given. If there are more, they should be listed under 'REFERENCES' at the end of the paper and referred to by date in brackets in the body of the article. Citation should give the name of the author (or authors), his (or their) initials year of publication and then the full title correctly, followed by the name of the Journals, number of the volume, a colon and page numbers. If the title is in a foreign language, then diacretic signs and capitalization should be precisely as in the original. The names of the Journal should be as abbreviated in the WORLD LIST OF PERIODICALS, 2nd Ed., 1934, but as that book may not be available to all, contributors are requested to give the titles in full. Abbreviating will in that case, be done by the Editors. If an article has not been seen in original, then that fact should be clearly stated. An example citing is given below:—

Conovor. R.A. (1948)......Studies of two viruses causing mosaic diseases of soyabean. *Phytopathology*, 38 : 724-735.

Because of high cost of half-tone blocks carefully made linedrawing on Bristol board in black ink will be preferred. Photographs when necessary should be printed on glossly contrast paper and be of best quality. Full page figures and photographs should be made to reduce $4 \times 6\frac{1}{2}$ inches, the standard size for all plates. Each author is allowd one page of half-tone illustration for each article or its equivalent and the cost of half-tone blocks and paper in excess will be charged to author. Drawings must be drawn to standard scales, so that they can be compared with one another *e.g.*, $\times 10$, $\times 50$, $\times 100$, $\times 250$, $\times 500$ etc. It is not always possible to get magnification at a round figure with a camera lucida but the printer can readily reduce drawings at any magnification to the standard, provided a scale is added to the drawing. The scale should measure from 5 to 10 cm. the longer the better and the printer should be instructed to reduce this line to the desired magnification.

Authors are invited to consult Bisby's 'An Introduction to Taxonomy and Nomenclature of Fungi' (1945), p.p. 38-41 and Riker's 'The preparation of manuscripts for *Phytopathology*, *Phytopathology* 36 : 953-977, 1946, before preparing their mss. and figures.

Articles will be published in the order of their approval for publication but the address of the retiring President and invitation articles will be published when received.

To comply with the International Rules of Botanical Nomenclature, Latin descriptions must be supplied to validate new species and genera.

Authors requiring reprints with or without covers should place an order for the copies wanted at the time of returning the proofs and they will be charged actual cost.

INDIAN PHYTOPATHOLOGICAL SOCIETY

INDIAN PHYTOPATHOLOGY is the official organ of the INDIAN PHYTOPATHOLOGICAL SOCIETY. It is sent free to members in good standing but for others the annual subscription is Rs. 14/- (£1-1-0 or $4-50), post free, and payable in advance. Subscriptions should be sent to the Secretary Treasurer, INDIAN PHYTOPATHOLOGICAL SOCIETY Pusa Buildings, New Delhi, India.

Published & Edited by R. Prasada for the Indian Phytopathological Society
Pusa Buildings, New Delhi-12
and Printed at Oxford Printing Works, New Delhi.